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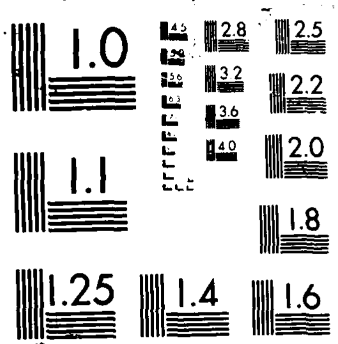
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AN ALTERNATIVE METHOD FOR ALLOCATING BASE MAINTENANCE SUPPLIES TO MISSION, DESIGN, AND SERIES AIRCRAFT IN THE UNITED STATES AIR FORCE

THESIS

David F. Cortez, B.A.
Captain, USAF

AFIT/GSM/LSY/87S-7

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AFIT/GSM/LSY/87S-7

AN ALTERNATIVE METHOD FOR ALLOCATING BASE MAINTENANCE SUPPLIES TO MISSION, DESIGN, AND SERIES AIRCRAFT IN THE UNITED STATES AIR FORCE

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements

for the Degree of Master of Science

in Systems Management

David F. Cortez, B.A.

Captain, USAF

SEPTEMBER 1987

Acknowledgments

This document represents the culmination of a research project and symbolizes the beginning of the application of the education obtained at the Air Force Institute of Technology. Its completion also signifies a time to express gratitude.

There are many who deserve thanks and credit not only for this product but also the opportunity to obtain a Master of Science Degree during an arduous period of separation from my sons, Patrick and Adrian. First, to my parents - thank you Mom and Dad for your love and wonderful care of my sons during my stay at AFIT. Second, God Bless You, Patrick and Adrian, for your patience, understanding, encouragement, maturity, and love. Without your strength, I could not have ever made it through this program.

I am also indebted to Colonels Lee Haines, Jim Anderson, and Chuck Crawford for their support and special assistance getting me to AFIT. They have seen fit to continue to challenge me and make me work toward the future. I would be remiss if I didn't say thanks to all the fine professionals in the Comptroller family throughout the Air Force who wished me well as I entered this program.

Lt Col John Wallace, Hq USAF/ACC, provided the topic for this research and provided ample advice and background on the subject. Similarly, Maj Chuck Hanna and Capt Ron Carver were instrumental in helping obtain data and explaining the intricacies of VAMOSC. Then, Mr Steve Kianka, LSMC/SMMA provided important historical data and insights on the allocation algorithms used in this thesis. Finally, several of the professionals at Hq ATC/ACC were also helpful in obtaining data. Thank you all very much!

I also owe a very special thank you to my many friends at AFIT, especially my peers in the Cost Analysis Program and to that group of special friends in "Seminary Eight!" It comes as no surprise when I say, "We laughed, we learned a lot, and we shared a special part of each other."

Finally, I owe a huge debt to my academic and thesis advisor Major William F. Bowlin, who provided the professional advice and guidance to see me through this thesis. A special thanks also goes to Mr Rich Murphy for his regression expertise and assistance.

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Abstract

Fiscal legislation dictates the prudent, yet effective and efficient use of government funds for Department of the Air Force programs. Much attention has focused on the increased cost of weapon systems and on providing an accurate track of total weapon systems costs. Sophisticated data collection systems such as the Visibility and Management of Operating Support Cost (VAMOSC) system have been created to help track these costs.

Currently, supply and accounting computer systems do not fully capture the costs of aircraft supply issues by mission, design, and series (MDS) aircraft. Therefore, a cost allocation procedure is used to charge the costs of common items (bench stock) to specific aircraft by using a ratio involving maintenance man-hours.

This research investigates the relationship between unallocated base maintenance supplies (BMS) cost and several potential cost drivers using regression analysis. The study identifies the key relationship that drives cost and incorporates this knowledge into the allocation algorithm. Data for this study come from a stratified sample of flying training aircraft in Air Training Command. Eight bases are used reporting data for primary aircraft authorized (PAA), sorties, maintenance man-hours, flying hours, and direct BMS costs for FY 84-86.

In answering the research questions, relevant literature, expert opinion, and *a priori* judgment were used to select potential cost drivers. Then a regression model was derived and statistically tested for linearity, strength of association, and aptness.

The derived model indicated the best relationship between the given variables and unallocated BMS cost occurred when PAA is used. Empirical evidence is given to refute the use of maintenance man-hours in an allocation algorithm.

In the conclusion, a sample allocation calculation using PAA and maintenance man-hours is provided for comparison. Also, recommendations are made for future study and a comprehensive three month review of BMS issues is suggested.

AN ALTERNATIVE METHOD FOR ALLOCATING BASE MAINTENANCE SUPPLIES TO MISSION, DESIGN, AND SERIES AIRCRAFT IN THE UNITED STATES AIR FORCE

I. Introduction

General Issue

Historically, cost factors have been used by Comptroller activities to estimate the cost of resource requirements, including budgets and life cycle costs, for United States Air Force (USAF) programs. The National Estimating Society's *Dictionary of Cost Estimating Terms and Phrases* defines a cost factor as:

> A cost estimating relationship (CER) in which the cost is indirectly proportional to a single independent variable. A brief arithmetic expression wherein cost is determined by application of a factor such as percent, e.g., initial spares percent, general and administrative percentage, or a ratio as in pay and allowance cost per man year [32:41].

As used in this thesis, cost factors are classified into two types: budget year and life cycle. Differentiation between budget year and life cycle costs and cost factors will become apparent as this research is developed. Currently, Hq USAF officially computes and publishes cost factors on at least an annual basis. The factors are governed by Air Force Regulation (AFR) 173-13, *USAF Cost and Planning Factors*, under the direction of the Cost Program Division, Air Force Directorate of Cost (Hq USAF/ACC). A second organization actively involved in the cost factor business is the Cost and Economic Analysis Division, Directorate of Comptroller Support, Air Force Accounting and Finance Center (AFAFC/CWM). It is responsible to Hq USAF/ACC for developing specifically identified cost factors. This activity has been moved to the Pentagon.

Recently, the development and use of cost factors have come under close scrutiny by Hq USAF Comptroller officials due primarily to increased emphasis on accurate budget and program estimates. During the 6-10 October 1985 planning conference directed by Lieutenant General Truman Spangrud, then Comptroller of the Air Force, an update was made to the Comptroller Long Range Objectives and Strategies Plan (AC 90). One of the action items validated was an initiative to upgrade the Visibility and Management of Operating Support Cost (VAMOSC) program (VAMOSC will be explained later in this thesis) in order to identify the cost of base maintenance supplies at the mission, design, series (MDS) level of detail to support cost factor development (42:1-2). During AC 90's validation and approval process, every Major Air Command (MAJCOM) comptroller and director of cost had to concur with the action items which were to be retained in the AC 90 plan. Thus, by allowing the VAMOSC upgrade initiative to be included in the plan, our senior comptroller officials not only endorsed its validity, but also indicated that this effort is important to improving the base maintenance supplies (BMS) cost factors.

According to AFR 173-13, the BMS factors "measure expendable supplies directly associated with the flying mission (such as nuts, bolts, small tools, ground fuel, and aviation fuel for other than flying purposes)" (19:3-4). The action officer responsible for the BMS cost factors is Lieutenant Colonel John M. Wallace, Chief of the USAF Logistic Factors Team, Hq AFAFC/CWM. Based on an interview with Lt Col Wallace, BMS cost factors need to be reviewed to determine if they can meet a desired level of accuracy and to validate the cost allocation procedure used in computing these cost factors (42).

Specific Problem

In a letter to the Air Force Institute of Technology, Lt Col Wallace wrote that approximately 20 to 30 percent of BMS expenditures cannot be specifically identified to specific Mission, Design, and Series (MDS) aircraft (e.g., C-130E, B-52H) when parts are issued to maintenance organizations from base supply activities (42). The problem lies in the current base supply issue procedures. Generally, purchases or issues of supplies used for the maintenance and repair of base level activities are accounted for by organization. Subsequently, financial reports, which summarize supply expenditures, are produced periodically. However, for aircraft maintenance there are two issue procedures.

First, some supply items are ordered for specific aircraft by tail number or other identifier/accounting code (In fact, some cost factors require calculations using data that has been maintained by type of aircraft). These supply items are recorded directly into the Air Force's general accounting system thereby, allowing a cost track of supplies by aircraft.

In the second issue procedure, other aircraft parts, like common screws, bolts, and small tools (commonly referred to as bench stock), are ordered and issued to a central supply activity within the aircraft maintenance organization. In turn, the maintenance organization merely hands out the parts to mechanics as needed for aircraft repair. These supply items cannot be traced to specific aircraft using the accounting system as it works today. Since it is desirable to maintain cost information on aircraft by specific type or MDS, this procedure of centrally stocking certain supply items in the organization leads to a somewhat incomplete capturing of cost by MDS in the financial reports. It further results in the use of a cost allocation procedure to charge the centrally stocked items to each MDS when the BMS cost factor is developed.

Currently, BMS costs are allocated to MDS aircraft based on maintenance man-hours (MMH) used for repair. Lt Col Wallace has "no idea if using MMH is a valid (and hopefully accurate) procedure to allocate base maintenance supplies or if there are better allocation procedures which more closely approximate the actual consumption" of maintenance supplies (42:2).

The purpose of this research is to identify and test various methods for allocating the unallocated BMS costs and recommend to the Air Force an allocation procedure which reflects the best underlying consumption pattern by MDS aircraft.

Scope

This research will be limited to a review of selected aircraft assigned to Air Training Command. Additionally, Fiscal Years 1984-86 data on both aircraft and base maintenance supplies costs will be used. Although this will limit the generalizability of the results of this research, the results will still be of value for the specific aircraft used and should provide insight into the appropriate allocation procedures to be used for other aircraft.

Justification for Research

There are several reasons for conducting this research. First, cost growth has become a significant factor which the Department of Defense (DOD) must control. This can be illustrated with a simple cost comparison between the P-38, a World War II fighter aircraft, and the relatively new F-16 fighter.

In a videotape demonstrating the capabilities of the Visibility and Management of Operating and Support Cost system, the following information was presented:

P-38		F-16
$ 28,000	Engine	$1,959,000
68,000	Airframe	3,936,000
4,000	Electronics	1,739,000
15,000	Other Systems	567,000
$115,000		$8,201,000

The information above shows that a fighter's cost today is over 71 times the cost of a World War II fighter (40). Granted, the comparison is somewhat oversimplified; yet, it graphically emphasizes the increased costs.

One way to help control costs is by upgrading the systems used to track or collect costs. This way management can better monitor costs and help control cost growth. Currently, USAF weapon system costs are collected by the VAMOSC system. Item number 4a102 is an initiative in the AC 90 action plan specified to help improve the VAMOSC system so that all costs associated with weapon systems are accounted for. The completion of this action item will allow for total automation of the BMS cost factor development and eliminate the need to allocate costs. Since the VAMOSC initiative proposed a fix for a large, complex automated system, the BMS allocation procedure must continue until the action item is completed. Therefore, a review of this procedure is both logical and necessary.

Preliminary research indicates the validity of using maintenance man-hours (MMH) to do cost allocations is in question. The question is based on several critiques and comments found in government reports and correspondence, remarks obtained from a variety of interviews with military experts, civilian research center findings, and contemporary business literature. Concerns and criticisms are addressed specifically in Chapter III, Literature Review. An underlying purpose of this thesis is to analyze the MMH concept for allocations and determine its validity for use in other cost allocations.

Given the knowledge that the BMS cost factor is often the basis for funds distributions or estimates of future base-level aircraft maintenance costs and life cycle costs of developing systems, the accuracy and validity of cost factors is extremely important. Improper budget allocations for maintenance supplies to Strategic or Tactical Air Command based on a 20 to 30 percent error in the BMS cost factor could lead to an unnecessary fiscal "belt tightening." This could impair the ability to surge or sustain our involvement in protracted contingencies.

Beyond these points, Lt Col Wallace believes this research may make "an invaluable contribution to the Air Force Cost Analysis Program" (42).

A final comment on the benefit of this research is based on a specific responsibility of the Chair of the Cost Analysis Improvement Group (CAIG). According to Department of Defense Regulation (DODR) 5000.39, the Chair of the CAIG "shall issue guidance for military service programs to improve cost-estimating techniques and data bases" (20:6). This thesis is totally dedicated toward this objective.

Assumptions

In order to conduct this research, these assumptions were made:

1. There is some systematic, measurable relationship between weapon system flying hours, sorties flown, primary authorized aircraft, maintenance man-hours, direct costs, and the costs which have to be allocated.

2. Some of these factors (herein called cost drivers) will have a greater impact on unallocated costs than others.

3. The relationship between the unallocated costs and the cost drivers is expected to be positive and can be expressed algebraically.

4. The model believed to properly reflect the consumption pattern for supplies is a regression model. Note that this premise will be tested in the research.

5. Regression analysis of the specific form following the first-order regression model for more than two independent variables will be used.

6. The unallocated costs are assumed to exhibit the relationships and properties of a linear regression model of the form (or some variant thereof):

$$Y_{ubms} = b_0 + b_1X_{fh} + b_2X_{paa} + b_3X_{sf} + b_4X_{mmh} + b_5X_{dbms} \quad (1)$$

where

Y_{ubms} = unallocated aircraft maintenance supplies costs by base

b_0, b_1, b_2, b_3, b_4, and b_5 are parameters to be determined by solving the model

X_{fh} = a known constant representing flying hours by base

X_{paa} = a known constant representing primary authorized aircraft by base

X_{sf} = a known constant representing sorties flown by base

X_{mmh} = a known constant representing maintenance man-hours by base

X_{dbms} = a known constant representing direct maintenance costs that are charged to specific aircraft

7. The results of the regression analysis will help determine the basis for allocating the unallocated BMS costs.

Research Questions

The following questions will be answered in this thesis:

1. How are BMS costs determined and collected. What makes up the unallocated BMS costs?

2. What procedure is currently used to allocate BMS costs to specific MDS aircraft?

3. What parameters besides maintenance man-hours might be used to allocate BMS costs?

4. What testing procedures will be used to help identify a statistically significant cost allocation method for BMS costs?

Thesis Organization

Chapter I of this thesis has introduced the research problem, defended its utility, narrowed its scope, stated the key assumptions, specified research questions, and summarized the organization of this thesis. Pertinent background information concerning complex concepts, assumptions, and actions associated with this thesis are found in Chapter II, while a review of the literature associated with this treatise is at Chapter III. Subsequently, Chapter IV provides the methodology used to collect and analyze the research data. Then, the findings and statistical analyses used in this effort are documented in Chapter V. Finally, conclusions and recommendations based on this thesis plus proposals for follow-on studies are presented in Chapter VI.

II. Background

Chapter Overview

Prior to reviewing the literature for similar research and significant findings that may be germane to this project, it is important to develop some background to help explain the more complex areas, assumptions, and actions related to this research.

Cost Objectives and Direct Charges

A discussion of cost objectives and direct charges is helpful for reader comprehension of the concepts developed in this thesis. Fultz describes cost objectives and the role of management in establishing these objectives. According to Fultz:

> A cost objective is any function for which cost is accumulated. The decision to establish cost objectives is made by management based on its need for summarized cost information. However, decisions about establishing cost objectives are greatly influenced by the cost and time required to obtain this cost information.
>
> Cost objectives are classified according to management's use of the information. Two broad classifications are output cost objectives and organizational cost objectives. Examples of output cost objectives are products, client contracts, and other management projects... Examples of organizational cost objectives are plants, offices, departments, branches, or cost centers.
>
> ...A direct charge is one that is incurred for a specific cost objective. The charges must be positively related to that cost objective, and the cost objective must receive specific benefit for the cost incurred [26:2-3].

Fultz also gives an example that is somewhat analogous to this effort.

> If one considers the manufacture of an easy chair, it is clear that both labor to fabricate the frame and labor to cover the frame with fabric are direct costs (direct labor). Likewise, the wood in the frame and the material to cover the frame are direct costs (material). But what about the glue, tacks, and staples used in the construction? These materials are used in the final product as an other direct charge - if it were easy to measure their cost to the particular product or their cost could be included in overhead...
>
> Several minor expenses are frequently charged as indirect expenses because of the cost and difficulty associated with keeping records of these costs. A general rule to be followed is that if the cost of more precise measurement is greater than the benefit received, the cost should be treated as an indirect or overhead expense [26:7].

Essentially, this research seeks to account for these indirect costs as they relate to the cost objective called aircraft base maintenance. The focus is, on what Fultz would call, an output cost objective. The research is complicated by the fact that the Air Force's general accounting system is designed for use with organizational cost objectives. In fact, most accounting reports provide accounting information by cost centers. In the Air Force, these cost centers can be summarized into reports for installations, wings, and major air commands as needed. Although there are cost centers for specific aircraft, the actual process for determining an aggregate cost objective such as base maintenance supplies by type of aircraft is not straightforward. Fultz' general rule on cost objectives and indirect charges, shown in Figure 1, will be useful in conducting this thesis.

Direct Labor + Direct Material + Other Direct Costs + Indirect Costs =

COST OBJECTIVE

Figure 1: Schematic of Fultz' Rule for Cost Objectives

Cost Allocations, Joint Costs, and Common Costs

Three other important accounting terms that will be referred to frequently in this thesis are cost allocations, joint costs, and common costs. Biddle and Steinberg defined these terms as follows:

> A cost allocation will be defined here as the efficient partitioning of a cost among a set of cost objects. Borrowing a more descriptive term from Demski [1981], a cost allocation will be required to be "tidy," meaning that all of a cost is allocated, no more and no less. This definition in no way assumes that allocated costs will be useful. Usefulness depends jointly on the nature of the cost being allocated, the allocation method selected, and the decisions to be based on allocated costs.
>
> Joint cost will apply to a setting in which production costs are a nonseparable function of the outputs of two or more products...The focus in joint cost settings is the allocation of the joint production costs to the joint products and the uses (and usefulness) of the

> allocation in output decisions. The classic example of a joint cost setting is where a packinghouse allocates the cost of a steer between its beef and hide.
>
> Common cost applies to a setting in which production costs are defined on a single intermediate product or service which is used by two or more users...an example is the common provision of computer services to two or more divisions of a multidivision firm [5:3-5].

Thus, the terms cost allocation, joint cost, and common cost have been described in accounting terms. This thesis will focus on common cost allocations.

Life Cycle Costs (LCC)

The fundamental cost for Air Force programs and weapon systems is an aggregate known as life cycle cost. It is simply the total dollar value of the resources that a weapon system will consume from its ince ,ion through disposal by the government. According to AFR 800-11, Life Cycle Cost Management Program, life cycle costs are generally divided into four distinct categories: research and development (R&D), procurement and construction (or production), operating and support (O&S), and disposal (15:1). Typically, LCC estimates support budget estimates, Design-to-Cost programs, and management reviews directed by the Hq USAF and the Secretary of Defense. Under the umbrella of life cycle costs, operating and support costs are a primary category associated with weapon system costs and include the base maintenance supplies cost addressed in this thesis.

USAF Cost Factors Program

The cost factors program provides "decision makers and analysts at all levels with timely, accurate, and commonly used factors for decision making processes" (19:1). As mentioned earlier, the factors addressed in this thesis are formally called Operating and Support (O&S) cost factors. They represent a compilation of various "personnel, material, and facility costs, both of a direct and indirect nature that the Air Force incurs while operating, maintaining, and supporting the hardware and software of a weapon system" (19:1). Cost factors, then, are the standard or expected costs from the various fiscal appropriations that are used to estimate resource requirements and costs associated with Air Force structures, missions, and activities. Since these factors directly impact the ultimate expenditure of billions of dollars each year, they are the subject of periodic review by Hq USAF comptroller officials.

Budget Year Cost Factors. AFR 173-13 defines budget year factors:

> Budget year factors show the actual factors used by HQ USAF/ACB in developing the Air Force budget submission for the next fiscal year. These factors are based on requirements of that particular year. During a weapon system life cycle, many logistics costs are higher during early and later years, and less in mature years. Budget factors show these changes [19:1].

Most budget year factors are used to depict semivariable costs. Budget year factors are developed for the Program Objective Memorandum (POM) exercise. They are updated with fact-of-life changes for the Budget Estimate Submission (BES) and finally the President's Budget (PB). Budget year factors are derived from command inputs and Air Staff analyses.

Life Cycle Cost Factors. AFR 173-13 also defines life cycle cost factors:

> Life cycle factors account for the flow of costs throughout the economic life of a system. Life cycle cost factors are essentially the cumulative average of budget year factors, from initial operation through an average economic life. They provide a more accurate estimate of the total cost when preparing life cycle cost estimates [19:1].

Base Maintenance Supplies Factor. Life cycle BMS factors include all maintenance supply expenses and exclude other expenses, such as mission operations and administration. BMS factors represent DOD Functional Category 03 (Maintenance) and Air Force Element of Expense Investment (EEIC) codes 600, 602-607, 609, 61X, 64X, and 693. EEICs describe a type of commodity consumed; in this case, each of these 600 series EEICs represents a specific type of supply category. Functional Categories are used to aggregate the costs of each of the service components into a DOD summary account.

Unallocated BMS costs that are identified by the preceding EEICs must be distributed equitably to each aircraft by MDS at each base.

The usual spread of EEICs that comprise the BMS costs is at Table 1.

Table 1. BMS Cost Percentage Breakout by EEIC
Source: AFR 173-13

EEIC	PERCENT
605	46
609	39
641	3
693	7
Other	5

The BMS factors measure expendable supplies directly associated with the flying mission. BMS costs are considered to be totally variable and linearly related to the flying-hour program according to AFR 173-13. They exclude costs associated with Depot level maintenance for larger and usually more expensive aircraft components and parts. Figure 2 depicts the relationship of the BMS factor to Life Cycle Cost.

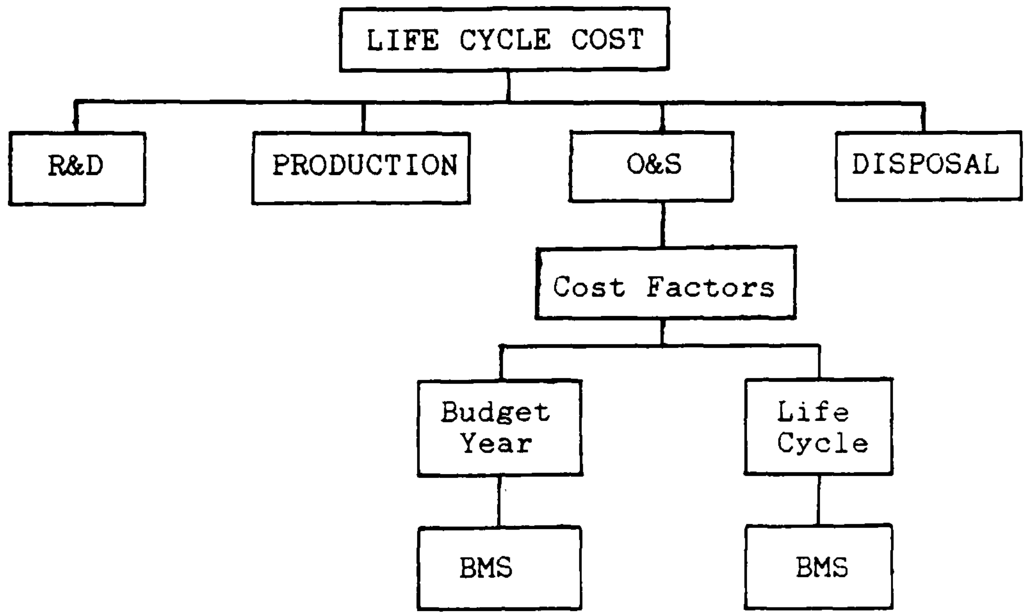


Figure 2: Relationship of BMS Factor to Life Cycle Cost

The cost allocation techniques being evaluated in this thesis support the development of the BMS factors which are life cycle cost factors. According to Lt Col John Wallace, the results of this thesis will be used to standardize the cost allocation techniques currently used by the Air Force to develop both life cycle and budget year cost factors.

Project AC 90

Project AC 90, initiated 17 February 1982 by Lieutenant General George M. Browning, Jr., Comptroller of the Air Force, was a step in developing a "sound and continuous long-range planning process for Comptroller operations" (6). The initial product was a 58-page document which charted the management initiatives that were then envisioned to carry USAF Comptroller organizations into the 1990s (14).

Later, when Lieutenant General Truman Spangrud became the Comptroller of the Air Force, both he and the Assistant Secretary of the Air Force for Financial Management, the Honorable Richard E. Carver, revitalized Project AC 90. Many initiatives were identified in the new plan to help improve Comptroller capabilities (38).

This thesis is based on one of the AC 90 action items. The action item is a proposed improvement to the Visibility and Management of Operating and Support Cost (VAMOSC) system. VAMOSC is explained in the following section.

VAMOSC

A program designed to assist managers in the financial decision making process and which provides the data for computing cost factors is the Visibility and Management of Operating and Support Cost (VAMOSC) Program governed by AFR 400-31 and managed by the Cost Directorate, Headquarters Air Force Logistics Command (Hq AFLC/ACC). As previously stated, improvement of the VAMOSC system will subsequently improve cost factor development. A brief history and explanation of VAMOSC follows.

Genesis of VAMOSC. In 1975, the Honorable W.P. Clements, Jr., Deputy Secretary of Defense, sent a memorandum to the service chiefs providing the initial guidance to develop weapon systems operating and support cost visibility using automated systems (7). Ninety days later, the Visibility and Management of Operating and Support Cost (VAMOSC) system was created to support planning and budgetary requirements related to weapon systems. The VAMOSC system then evolved into three large data systems governed by AFR 400-31. The three systems that initially evolved were the Component Support Cost System (CSCS), the Operating and Support Cost Estimating Reference (OSCER), and the Communications-Electronics Logistics Support Costs Management Program. Subsequently, from 1976 through 1979, numerous revisions and updates were made to VAMOSC's cost systems in order to improve their performance and clarify responsibilities. According to the Executive Summary For VAMOSC, a data project directive (a major computer system project) was issued to enhance all three systems and consolidate their management (12). The three resulting cost systems were the Weapon Systems Support Cost (WSSC) System, the Communication-Electronics (C-E) System, and the Component Support Cost System (CSCS). Each is described below.

A. Weapon System Support Cost (WSSC) System - This system was designed to collect operation and support (O&S) costs at the weapon system level. The WSSC system reports on over 100 aircraft at mission design series (MDS) level. This system continually gathers data from several automated and manual inputs. Three examples of input data and the numeric designator for the input data reports are:

1. Accounting and Budget Distribution System H069R - includes operations and maintenance dollars spent in any given fiscal year.

2. Aerospace Vehicle Inventory Status/Utilization Report G033B - provides flying hours for every aircraft by tail number and the average primary aircraft authorized (PAA) by base.

3. Product Performance System File D056A - gives the number of maintenance man-hours expended at each base.

B. Communications-Electronics (C-E) System - This system was designed to collect and portray cost at the type model series (TMS) level. There are approximately 850 TMSs that data is collected and reported on. Three examples of the input data and report numerical designators for the C-E system are:

1. Engineering/Installation Management C003K - provides mobile depot maintenance costs.

2. Recoverable Consumption Item Requirements System D041 - gives recoverable subassembly information on communication items (price, condemnations).

3. Equipment Item Requirements Computation System File D039 - includes inventory information and purchase prices for end-items.

C. Component Support Cost System (CSCS) - This system provides quarterly information on the cost of aircraft subsystems and components. Costs are reported by work unit codes (WUC) and MDS. Fifteen data systems provide inputs. Three input examples are:

1. Comprehensive Engine Management System D042A - identifies the engines classified as not reparable this station (NRTS) and sent to depot for repair.

2. Base Account Screening Exercise D0465 - provides information on interchangeable and substituteable national stock numbers (NSN) for component parts.

3. Depot Maintenance Industrial Fund (DMIF) Cost Accounting Production Report - gives depot average repair costs and labor hours.

Based on the preceding discussion alone, readers can begin to appreciate the size and complexity of the VAMOSC system (12:1-12).

Recent VAMOSC Developments. The most recent actions affecting the VAMOSC system were based on an OSD requested assessment of VAMOSC in 1986, a subsequent study done by The Analytical Science Corporation (TASC) in 1987, and a major system update that directly affects the allocations being evaluated in this thesis. Details of the first two actions are reported by Sisco during her research of VAMOSC overhead algorithms done concurrently with this research effort. A review of her research follows:

1. A transfer of function for VAMOSC was deemed appropriate. Effective October 1986, this transfer occurred from Hq AFLC/MML to Hq USAF/AC.

2. The office of primary responsibility for VAMOSC was transferred to the Air Force Cost Center, while Hq AFLC/AC was given operational program responsibilities for VAMOSC (36:8-9).

Similarly, Sisco reported on a TASC study titled, Get Well Modernization Plan for the VAMOSC System. She reported that TASC found several minor problems with the WSSC and CSCS, but major problems with the C-E system. She also reported Hq AFLC/AC actions in response to the TASC study. Actions initiated since the March 1987 report include:

1. Improving the system which cross-references work unit codes and national stock numbers in the CSCS.

2. Developing a plan to transfer VAMOSC to IBM compatible computers to simplify user downloading and uploading information.

3. Requesting specific guidelines on VAMOSC from the Air Force Cost Center (36:9).

One final development that will be addressed here is the upgrade of VAMOSC's Component Support Cost System. The enhancements are identified in Information Systems Requirements Document (ISRD) AFC-H86-110 submitted by the Material, Cost and International Accounting Systems Division and the Comptroller Systems Development Division, Directorate of Plans and Systems, Air Force Accounting and Finance Center (AFAFC/XSM and XSD respectively). This ISRD requests an update to a related VAMOSC input source, the Standard Base Supply System (SBSS), that will eliminate the need for the cost allocations currently used. The modified system will specifically identify costs:

> ...by element of expense investment code (EEIC) and responsibility center cost center (RC/CC) code at the MDS level of detail for aircraft and Type, Model, Series (TMS) level of detail for aircraft engines. (RC/CC codes are used to identify the organization or activity and sometimes the aircraft used to accumulate costs.) The SBSS identifies issue transactions to weapon systems by use of the Standard Reporting Designator (SRD). The SRD relates directly to aircraft MDS codes as well as aircraft engine TMS codes [9:1].

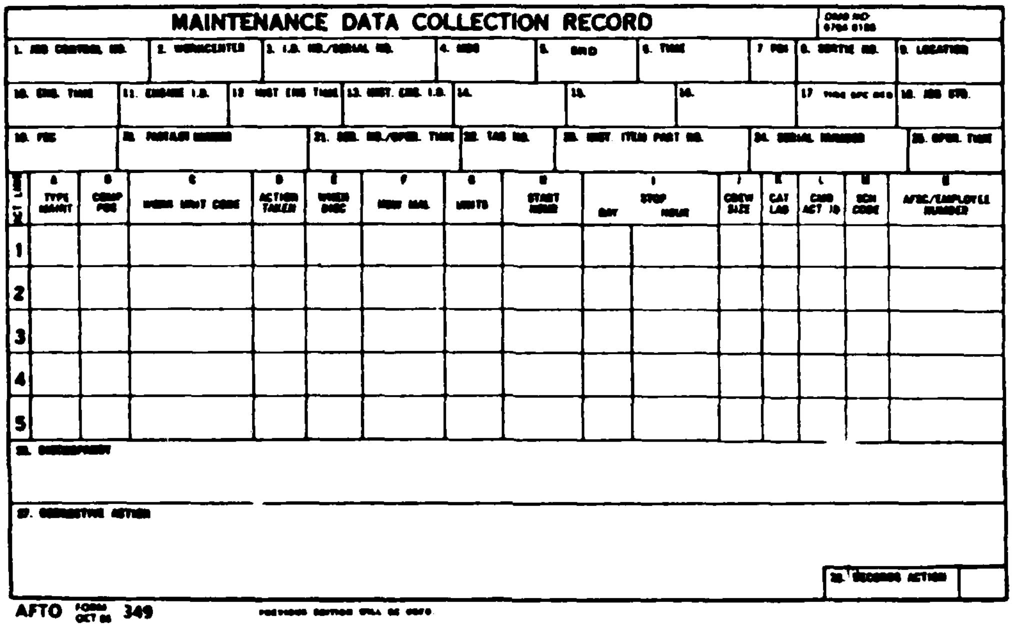
VAMOSC and This Research. The VAMOSC is an integral part of this thesis. The BMS cost factors are developed using data collected in and reported by VAMOSC. The allocation procedures being researched in this thesis are only being used because of some practical limitations of the Air Force's accounting system and the standard base supply system. Recalling Fultz' general rule, more precise measurement may not be worth the cost of a "super" VAMOSC system. Despite the request for another system upgrade for VAMOSC (expected to eliminate the need for manually allocating costs), the underlying basis for cost allocations still remains questionable. This research may affect the way certain data is manipulated using the VAMOSC algorithms.

Maintenance Data Collection (MDC) System

General Concepts. Maintenance data is an important factor in determining the reliability and maintainability of weapon systems. The Maintenance Data Collection (MDC) system is the primary source for a variety of data associated with base-level maintenance and repair of weapon systems. Base-level maintenance consists of both scheduled and unscheduled work.

Generally, unscheduled work is identified by aircrews as a result of equipment failures. Debriefing personnel obtain this data from the crews and relay it to the Job Control Section of the base maintenance activity which in turn schedules the work to be performed by maintenance personnel.

Scheduled maintenance is performed after an aircraft accumulates a certain amount of operating hours. The Documentation Section in the maintenance activity keeps records on each aircraft and identifies when schedule maintenance is needed. Eventually, the appropriate specialists are dispatched to perform the work. Whenever work is performed on any aircraft or aircraft component, maintenance personnel are required to complete AFTO Form 349. Data required to be collected includes maintenance staff-hour (man-hour) expenditures and technical data involving the repairs. The data is then keypunched, and processed at bases for report generation, computer storage, and other uses. These data feed into systems like VAMOSC and often form the basis for cost allocations and cost factor computations. Figure 3 shows a sample AFTO Form 349.


MAINTENANCE DATA COLLECTION RECORD

AFTO FORM 349

Figure 3: AFTO Form 349

Maintenance Configurations. According to the Logistics of Waging War, Air Force maintenance squadrons have been governed by AFR 66-1, Maintenance Management, since the 1950's. The collection and reporting of maintenance data at most Air Force installations have, therefore, used the centralized maintenance concepts specified in AFR 66-1 with centralized control under a chief of maintenance. The maintenance concepts used by the principle operational major commands are shown in Figure 4. Typically, under AFM 66-1, four maintenance squadrons will function under the direction of the Chief of Maintenance: field maintenance (FMS), organizational maintenance (OMS), avionics maintenance (AMS), and munitions maintenance (MMS).

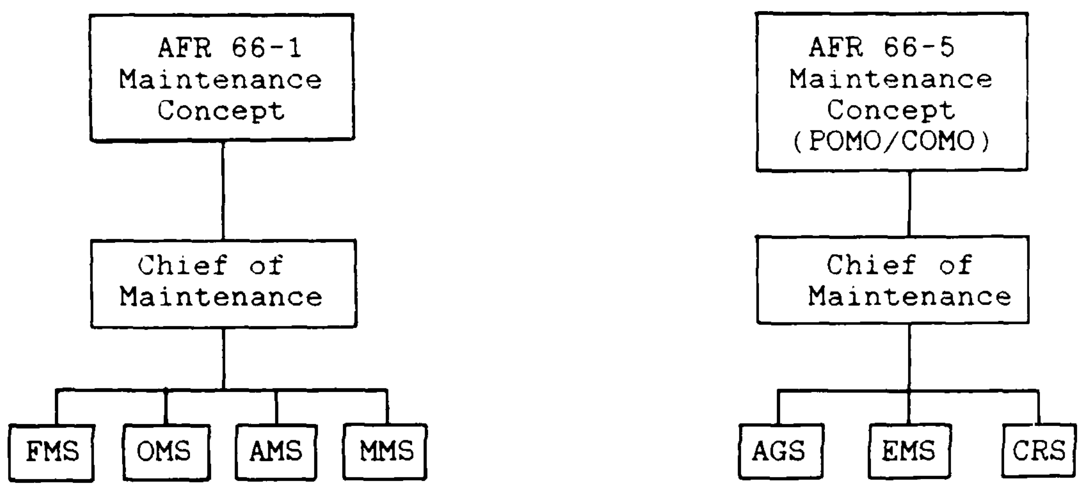


Figure 4: Maintenance Configurations

During Viet Nam, Pacific Air Forces (PACAF) used tactical units for maintenance, which essentially deleted organizational maintenance and assigned its function to a tactical flying squadron, along with munitions squadron load crews. These tactical units were organized in matrix fashion, as would be termed in today's management philosophy. Similarly, Tactical Air Command (TAC) initiated a concept called the "TAC Enhancement." By the end of the

Viet Nam War, both TAC and PACAF reverted back to the organizational structure of AFM 66-1.

After Viet Nam, new ways to improve aircraft maintenance were sought. TAC initiated the Production Oriented Maintenance Organization (POMO) whose primary objectives were to increase operational mission effectiveness and to increase unit readiness. The concept deleted the four traditional maintenance squadrons and replaced them with these new maintenance squadrons: the aircraft generation squadron (AGS), equipment maintenance squadron (EMS), and the component repair squadron (CRS). Repairs were made according to two functions, on-equipment and off-equipment maintenance. TAC's POMO later transitioned into the Combat Oriented Maintenance Organization, or COMO as it is called today. POMO became formally recognized in AFR 66-5 as a second maintenance organizational structure and major commands were given the option to use either POMO or the AFM 66-1 concept (17). The 21 April 1983 revision to AFR 66-1 (formerly AFM 66-1) consolidated the maintenance concepts outlined in both AFM 66-1 and AFR 66-5 and depicted in Figure 4 (16:1). Even today both concepts are used.

Maintenance data collection under both concepts of maintenance organization is still based on the AFTO 349 previously discussed. Key data collected on this form that will be reviewed in this thesis include: maintenance man-hours worked, aircraft MDS, sorties, and work unit code.

Recent Developments. Maintenance data collection has been problematic. Evidence of this will be reported in Chapter III, *Literature Review*. The nature of the difficulty associated with maintenance data collection has to do with its labor intensive task. The Air Force has taken assertive steps to help alleviate the problem. The June 12, 1987 issue of the Air Force Systems Command *Newsreview* presented an article titled, "Maintenance documentation made easy." The Core Automated Maintenance System is introduced as the "latest leap forward in automation" and as having "maintenance specialists typing data into computers after they've completed a job and laid down their wrenches" (44:1). The system, referred to by its acronym CAMS, was successfully implemented at Edwards AFB, California on May 4 1987. The system supposedly can:

> ...help maintenance personnel keep track of which aircraft and support equipment need repairs or inspections, which items have had work done on them, when members require training, and all the many details needed to document such actions [44:1].

The overall objective of CAMS is reportedly to increase the efficiency of getting maintenance information. Since CAMS is proposed for complete implementation throughout the Air Force by the year 2000, perhaps many of the problems of maintenance data collection will subside.

Cost Accounting Standards Board and Allocations

Due to the increasing complexity of government procurement, the Cost Accounting Standards Board (CASB) was established in 1970. According to the Cost Accounting Standards Guide, the CASB was created by Congress to:

> promulgate cost accounting standards to be used by both contractors and relevant federal agencies in order to establish uniformity and consistency in cost accounting practices for government contract proposals and cost accumulation and reporting [8:2412,3497].

Cost Accounting Standard 418 discusses direct and indirect costs and states that cost allocations should be based on a beneficial or causal relationship, using:

> an appropriate measure of resource consumption, output measures if direct consumption measures are unavailable, or a surrogate that is representative of resources being consumed [8:2412,3497].

Chapter Summary

The background developed in this chapter has served several purposes. First, it is an attempt to familiarize the reader with the key concepts developed in this thesis. Beginning with cost objectives, direct charges, and the general rule developed by Fultz, readers should better understand the cost objective researched in this thesis. The cost objective, using Fultz's definition, is to determine the base maintenance supplies (BMS) costs for specific aircraft type. As was discussed earlier in this chapter, determining BMS costs is not a straightforward process, yet as Fultz reminded, if the cost of more precise measurement is greater than the benefit received then the cost should be treated as an indirect cost.

Subsequently, cost allocation, joint cost, and common cost were defined for the readers. Common cost allocations, or the partitioning of a product or service used by two or more activities, is an important definition because it depicts the type of allocations being analyzed in this document.

Next, life cycle costs were addressed and readers were reminded that this category of cost is the aggregate term used for all costs associated with weapon systems from inception to disposal. Under the umbrella known as life cycle cost is the category known as operation and support (O&S) costs, a primary category for weapon system costs. The BMS costs are a subset of O&S costs.

In the next section of this chapter, the USAF cost factors program was explained. Descriptions of the budget year factors and life cycle cost factors were given. This section continued the background development for this thesis by showing how the BMS cost factor, a budget year factor, is used. The allocation methods being researched in this thesis should be useful in standardizing the way the Air Force computes all cost factors.

Following the discussion on cost factors, Project AC 90 was presented. Beyond the fact that Project AC 90 resulted in the development of the strategic plan for the USAF comptroller organization, the specific action item from which this research is based was approved by all MAJCOM comptrollers and cost directors. This indicates, in part, the significance of this study and the high level visibility that it has. The action item itself relates to an initiative designed to upgrade the large computerized system that maintains the data elements supporting all weapon systems. This computerized system is known as the Visibility and Management of Operating and Support Cost (VAMOSC) program.

VAMOSC's history (including several examples of the primary systems and the input reports) was depicted, along with recent developments even as this research was conducted. Historically, VAMOSC has been continually changing both to improve its products and management. Recent changes to VAMOSC were driven by an OSD requested assessment and a study done by TASC. These changes included the elimination of the Communications-Electronics system and a major reorganization which transferred VAMOSC to the Air Force Cost Center with operational control remaining at Hq AFLC/AC. In addition, an important upgrade to the Component Support Cost System will ultimately alleviate the need for cost allocations. Albeit, VAMOSC data is an integral part of this thesis. It will be used to conduct a regression analysis in order to try to determine the best base for cost allocations.

Since this thesis is looking at base maintenance supplies and an allocation technique originally based on maintenance man-hours, it was important to describe the Maintenance Data Collection (MDC) system. Maintenance data is not only instrumental in determining the reliability and maintainability of weapon systems, but also in providing data useful for a variety of cost factors developed from the VAMOSC system. This portion of the chapter described the two maintenance concepts (AFR 66-1 and POMO) currently used in the Air Force and described the specific steps and forms used to report the maintenance data used in this thesis.

Finally, since the thrust of this thesis is directed at cost allocation procedures, the Cost Accounting Standards Board and allocation techniques were presented. These were discussed in order to depict the minimum standards expected for cost allocations and the basis for the accounting board's authority. Next, a review of the literature germane to this thesis is presented in Chapter III.

III. Literature Review

Chapter Overview

Historically, various cost allocations methods have been used both in military and commercial operations. This chapter provides examples of several methods used to allocate costs and explains the rationale for the various methods. Much has been written on the subject of cost allocations; therefore, this literature review has been organized in chronological order and by three categories: military, business, and academic publications.

Four types of military publications are reviewed to provide examples or critiques of cost allocation procedures and their use. Government Accounting Office (GAO) reports have long documented problems related to systems which maintain data used to allocate costs and have frequently critiqued these systems' usefulness and validity for use in the military. Similarly, the RAND Corporation has done a number of studies for the Air Force on cost allocations. Additionally, government contracted independent studies provide a different view of cost allocations. Finally, regulations and miscellaneous directives provide insights on cost allocations currently being used. All four types of publications provide a historical development and assessment of USAF cost allocation techniques and are essential to the conclusions reached in this thesis.

Business publications are also analyzed to try to isolate similarities in cost allocation techniques between civilian and military concerns and to determine the business basis for preferred allocation methods. A variety of periodicals and journals on cost accounting and business were reviewed. Finally, academic publications are reviewed to ascertain the most current cost allocation techniques that are being taught in educational institutions, are being used in industry, or which have been researched. This is intended to provide a current viewpoint from academia and will provide an interesting comparison with industry practices.

Military Publications

GAO Reports. Numerous Government Accounting Office (GAO) reports document problems related to the USAF cost factors program. These problems are directly related to the cost allocations being researched in this study. A comprehensive and highly controversial report published in 1983 addressed the problems associated with Air Force's Maintenance Data Collection (MDC) system. Recall that the MDC is the primary source of base-level maintenance data. GAO's 1983 report was titled, The Air Force Can Improve Its Maintenance Information System: Report to the Chairman Committee on Government Operations, House of Representatives and summarized a host of prior GAO reports on the subject of inaccurate data in the MDC system since its inception in

1958. A review of the report revealed that even officials of the Office of the Secretary of Defense (OSD) would not use reports based on MDC system inputs because "the recipient believed the output distorted aircraft maintenance costs" (28:50). GAO looked at Air Force in-house and contracted efforts to study the MDC system inaccuracies. In GAO's view, contracted studies showed:

-- The number of maintenance actions were under reported by a factor of 2.

-- The number of direct labor hours sampled by the contractor were over reported by a factor of 2 (28:12).

This important GAO report not only identified the long standing problem of inaccuracy in the collection of aircraft maintenance data but also in man-hour reporting. Maintenance data accuracy cannot be overemphasized, for as GAO pointed out, such data are used to not only monitor the effectiveness of Air Force maintenance programs including personnel productivity, but also weapon system operating and support costs. Equally important, maintenance data is used "to determine the reliability and maintainability of weapon systems" (28:2).

Thus, this GAO report provides strong evidence that historically there has been a problem with the accuracy of reported maintenance man-hours, the current base for the BMS cost allocations.

RAND Corporation Reports. Cost allocation techniques have been researched and reported on by the RAND Corporation since the early days of the Air Force. Among the earliest reports found was a RAND Corporation publication published in 1955 which discussed the use of cost allocation techniques to allocate the cost of interdependent support activities to mission activities. In this early effort, G.H. Fisher proposed a solution to the cost accounting problem of allocations through use of a model which solves systems of simultaneous equations in matrix form (24:16). Although he did not suggest any specific allocation bases or rationale, Fisher provided a mathematically rigorous cost allocation method early in the Air Force's history.

Later in 1961, David Novick's publication for RAND entitled, *System and Total Force Cost Analysis*, reported "For manned aircraft systems, maintenance cost is usually estimated as a function of flying hours, based on the cost factors for various types of aircraft given in the *Peacetime Planning Factors Manual*" (34:44-45). Mr Novick provided some of the early rationale for types of maintenance costs which could be allocated, but provided little evidence of some of the rationale for the current cost factors of the day. It appears the he took the flying hour factors from the factors manual without even questioning the reason or basis for their use.

Another RAND report cautioned readers on the need to establish meaningful bases for cost allocations. According to Kenneth E. Marks, et al, "Allocation methods that simply distribute costs in proportion to a convenient system characteristic (and which have little or no established relationship with the real cost driving factors) should be avoided" (31:viii).

The report also assessed life cycle cost estimating models for USAF aircraft systems. Its review included an assessment of AFR 173-10 (now AFR 173-13) models and defined the cause and effect relationship for maintenance material:

> The amount of material required is driven by the number of maintenance actions, which depends on the number of components, component failure rates, the number of aircraft in the force, and the level of activity. Policy decisions on the amount and type of work to be done at base level have a direct effect on the amount of material used [31:89].

Thus, Marks provided some insight into possible allocation bases for the allocation of base maintenance supplies.

A more recent RAND report of interest was "Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology." This report was prepared in March 1986 in response to a request by the Assistant Secretary of Defense (Reserve Affairs) and described a "methodology for estimating the annual operating and support costs of units in the active and reserve force components of the military services" (35:iii). This report was designed to help provide a consistent estimating method for force-mix decisions. Appropriately, Army, Navy, and Air Force active and reserve units were evaluated. Within the Air Force, active and reserve C-130F and F-4D squadrons were analyzed to determine unit operating and support costs. Significantly, the derived base level aircraft maintenance supply cost factor was expressed as a ratio of cost to flying hours. Based on this report, a flying hour based cost factor development process for base/unit level maintenance supplies is not only appropriate, but also inherent to consistent and standard cost estimating methods (35). Unfortunately, though an allocation base was identified, no rationale for selecting flying hours as a base for cost allocation was given.

Government Contracted Studies. Periodically, technical assessments or statistical evaluations have been made of the systems which the Air Force uses to track BMS costs and data. Reviewing a sample of these reports should provide insights to help determine cost allocation bases.

One such study performed by Desmatics, Incorporated in 1979 evaluated the accuracy of direct labor hour data used in estimates of operating and support costs. The principle objective of this study was to:

> ...assist the Air Staff in assessing the accuracy of the data which is input to the OSCER (previously discussed under the subheading: Genesis of VAMOSC) cost allocation methodology. Because base level maintenance activity constitutes a significant portion of weapon system operating and support costs, it is an area in which data accuracy may be expected to have an important impact [37:2].

Smith *et al* used a stratified sampling technique to observe direct labor hours used on F-15 aircraft at Langley AFB, Virginia and F-4D aircraft at MacDill AFB, Florida. Observations were conducted during three week periods at each location. Also, 119 maintenance jobs were reviewed under a sampling plan which was designed to be representative of the various weeks, days, shifts, squadrons, and work centers. A "Reporting Accuracy Factor," computed from the ratio of reported labor hours to observed labor hours, was selected as the response variable for statistical analysis. Results of the statistical analysis follows at Table 2.

Table 2. Results of Desmatics Statistical Analysis
Source: Smith *et al*

Base	Average Reporting Accuracy Factor	95% Confidence Interval
Langley	1.72	(1.40, 2.12)
MacDill	2.10	(1.62, 2.73)
Combined	1.94	(1.64, 2.31)

Thus according to Table 2, the Desmatics study implies:

> ...there is overwhelming evidence that the DLH data reported on the AFTO Form 349 at both Langley and MacDill reflects "inflation" of man-hours [37:35].

Table 2 suggests that 95% of the time the reporting accuracy factor for recording direct labor hours will range from 1.40 to 2.12 (or an average of 1.72) at Langley AFB and 1.64 to 2.31 (or an average of 2.10) at MacDill AFB.

The authors went on to suggest four possible methods for increasing the accuracy of direct labor hours. Included in their conclusions were adjusting the reporting accuracy factors, reducing the amount of maintenance documentation required by some fraction, adding permanent observers to the maintenance organization (charged with the responsibility of observing maintenance actions and just recording what is done), and substituting job standards in lieu of recording labor hours (37).

Another Desmatics study was done in 1983 to evaluate the cost allocation algorithms used in VAMOSC's Weapon System Support Cost subsystem. This study treated rigorously the entire cost allocation process and validated the use of direct labor hours (DLH) as a base for cost allocations. Desmatics' rationale for using direct labor hours was reported as follows:

> It is reasonable to question whether man-hours is the appropriate indicator of maintenance costs and strengths, and whether the use of man-hours in an allocation ratio produces the most equitable results. It is certainly appropriate to allocate pay and allowance costs and personnel strengths using man-hours. All of the variables involved relate to the

manpower needed to perform the required maintenance functions for an MDS.

With regard to maintenance material, the relationship to direct labor hour is less clear. The assumption is that the more man-hours spent maintaining a particular MDS, the more material costs would be incurred. This may be true to some extent [27:22].

Thus, this section of the report implies that direct labor hours might not be a useful base for allocation of base maintenance supplies. However, the authors conclude, "Although the DLH data is subject to reporting errors of omission and inflation, the analysis in this report indicates that the resulting inaccuracies do not vitiate allocation based on that data" (27:i).

Lastly, Information Spectrum Incorporated, (ISI), conducted a study to validate one of the VAMOSC subsystem allocation algorithms. The 1983 ISI report, <u>Validation of the Algorithm for Direct Material Cost for the Component Support System</u> (<u>D160 B</u>), included a review of a set of 30 algorithms for estimating or allocating costs. The effort included "investigations of logic, appropriateness of algorithms, and assumptions inherent in the algorithms" (23:ES-2). The report addressed the base direct material costs comprised of "consumable material issued by base supply organizations to maintenance shops for repairs of aircraft" (23:ES-2). The report also stated that since supply organizations maintained records by National Stock Number, not Work Unit Code, an allocation procedure was necessary to assign costs of material to subsystems and components. The allocation procedure used in VAMOSC to do this is based on the number of repair actions reported. In validating the use of this technique ISI identified three possible methodologies for allocation: "number of maintenance actions, number of maintenance events, or number of maintenance man-hours" (23:ES-3). ISI concluded that they could find no basis for preferring either maintenance events or man-hours to the number of maintenance actions for purposes of allocations.

Regulations and Miscellaneous Directives. Several regulations and directives address cost allocation techniques used by military cost analysts in their daily work. The reasons for using allocations appear to be as varied as the bases used to distribute costs.

Regulations. Among the regulations reviewed, AFR 173-13 lists a variety of cost allocation algorithms. Among the bases used to allocate funds is primary aircraft authorized (PAA). According to AFR 173-13, PAA represents the "aircraft authorized to a unit for performance of its operational mission. The primary authorization is the basis for allocation operating resources including manpower, support equipment, and flying hour funds" (19:139). Since PAA is a basis for distributing flying hour funds, it follows that PAA should be considered a possible base for allocating BMS costs. This will be evaluated in this thesis.

AFR 173-13 is not the only regulation that is useful for review. In Volume I of AFR 400-31, Visibility and Management of Operations and Support Cost Program Policy and Procedures, several input sources are described and suspenses levied for the data accumulated and used in the VAMOSC system. For example, data describing the aircraft inventory including flying hours, possessed hours (a surrogate measure for PAA), utilization, sorties, landing, and locations are maintained in the Possessed and Flying Hour Data File. This is one of many files maintained in VAMOSC. Additionally, input and reporting requirements must be consistent with the guidance provided in AFR 65-110, Aerospace Vehicle and Equipment Inventory, Status, and Utilization Reporting System (10; 11). Although the review of pertinent regulations has been cursory (there are too many regulations which relate to this thesis), it does provide ideas on potential cost drivers which can be evaluated as possible allocation bases.

Miscellaneous Directives. An OSD cost guide also provides direction on potential cost drivers. The use of maintenance man-hours is suggested for cost estimations, factor development, and allocations. One section of the 1984 Generic Cost Estimating Guide reported non-cost data elements and suggested how some of these elements could be cost drivers. Included as a useful indicator and cost driver for reliability and maintainability data was maintenance man-hours per operating hour (21:27).

Similarly, the _Operating and Support Cost Estimating Primer_ used by the Cost Directorate in the Aeronautical Systems Division of Air Force Systems Command provides many examples of cost factor equations and allocation algorithms for weapon systems. In one example, a combination of aircraft and maintenance characteristics are used to develop cost estimates for maintenance personnel cost and to distribute overhead. The formula in Figure 5 shows a maintenance personnel estimating equation using maintenance man-hours, primary aircraft authorized, and flying hours.

$$MP = \frac{(MMH/FH)\ (PAA)\ (FH/PAA\text{-}YR)\ (1.265)}{(AMPH)\ (12\ MONTHS/YR)\ (EEF)}$$

where:

MP = Number of maintenance personnel

MMH/FH = Average number of maintenance man-hours per flying hour

PAA = Primary aircraft authorized per squadron

FH/PAA = Annual peacetime flying hours per PAA

1.265 = Chief of maintenance and support equipment maintenance factor

EEF = Manpower efficiency factor: .75

Figure 5: Maintenance Personnel Equation (13:70)

Besides providing an example of a computation for computing cost estimates using the ratio of maintenance man-hours to flying hours, the primer also suggests that another useful ratio for the O&S cost analyst is maintenance man-hours per sortie (13). Although the guide is remiss in not providing a reason for using a ratio of man-hours and sorties, two more potential cost drivers are defined or described which may be investigated in this research.

Thus, from a review of these miscellaneous directives, the potential exists for a combination of characteristics to be used to depict the relationship between cost and BMS consumed.

Business Publications

Several business publications including journals and other periodicals were reviewed for a historical perspective on the subject of cost allocations. Of particular interest were writings which were related to government transactions and that might be useful for this research.

Journals. Several articles have been written on ways to allocate costs. In July 1964, Williams and Griffin wrote an article in *The Accounting Review* which discussed the allocation of costs using matrix theory. Later, in October 1964, Churchill recommended the use of linear algebra to allocate costs. Chiu and DeCoster wrote on using multiple correlation analysis for multiple product cost allocations. This research was published in *The Accounting Review* in

1966. In 1968, Brief and Owen published an article on cost allocations in the Journal of Accounting Research. They suggested a mathematical model for allocations which used the generalized least squares model. Later in 1971, Kaplan and Thompson suggested the use of linear programming to do cost allocations of overhead. Another technique used to allocate costs is a method based on game theory. In 1978, Callen wrote about using the Shapley technique of game theory for time-dependent financial cost allocations.

Beyond these purely mathematical techniques, variants of each have been developed to consider nonquantitative factors. For example, in 1977 Bodnar suggested a cost allocation method which considered a behavioral analysis of joint cost allocations and transfer pricing (30:102-112).

Thus, this portion of the literature review suggests that there are numerous ways (methods vs bases) to allocate costs and there appears to be no generally accepted methodology. Ayres' 1985 article on cost allocations reinforces this point:

> Despite the significant resources that have been invested by accounting researchers in development of new cost allocation methods and in justifying the preferability of their espoused method vis-a-vis other methods, there has been no apparent move toward adoption of these normative models in practice...[3:1].

Another interesting article that provides a historical foundation for cost allocations was written by Anthony. In the inaugural issue of The Journal of Cost Analysis in 1984, he presented a historical review of cost allocation literature, noting that most of the principles were developed during the 19th century. These principles included the distinction between direct and indirect costs, prime costs, fixed and variable costs, overhead rates, bases of overhead allocation, job order and process costing, and by-product costing. Anthony observed that by the early 20th century, standard costs and variance analysis were discussed in the literature and used in practice.

According to Anthony, the principle problem remained in how indirect costs should be allocated to products or other cost objects. From a historical viewpoint, he observed:

> Fifty years ago, cost accountants were well acquainted with allocation techniques, and texts and academic literature faithfully reflected these practices. Beginning in the 1940s, however, the literature diverged from practice, and the divergence continues today...Prior to 1940, academic literature devoted considerable attention to cost allocation. Of the eight leading cost accounting texts published in the 1930s, each devoted a minimum of two chapters to this topic, and some had as many as five. In the 1940s and 1950s, however, a new attitude developed. Its general theme was that cost allocations were at best useless, and at worst misleading. Textbook authors discussed cost allocations briefly and disparagingly, and they discussed the topic at all only because they felt an obligation to say something about a commonly used practice, even though they regarded it as being outmoded [1:5].

Anthony generalized that the change in educational philosophy on cost allocation occurred in 1936 with an article published by Harris which focused on direct costing. Authors such as Robinson Clark, Dean, and Grant (all managerial economists of the 1940s and 1950s) wrote about linear programming and other operations research techniques developed during and after World War II which fueled the change. Anthony notes that even the noted economist, Samuelson, compounded the problem with the development of microeconomics. Allocated costs were irrelevant to the techniques of microeconomics. Next, when Higgins developed the idea of responsibility accounting, cost allocations were not required. The new theme was fully developed by the time Horngren published the first edition of Cost Accounting in 1962. Anthony went on to discuss the errors involved in steering away from the subject of cost allocations and provided examples of numerous authors including Horngren who have now become supporters of cost allocations and are publishing more on the subject. In his conclusion, he offers this advice to researchers in cost accounting:

> If researchers would recognize that the solution to these problems are by no means "arbitrary" in the sense of capricious, some might divert their work from completely impractical problems, such as trying to measure the value of information, and tackle these topics [1:14].

Thus, from this author's historical view, the subject of cost allocations is indeed quite controversial. The importance of allocation methods and the controversy involved with the techniques currently used are echoed throughout this thesis.

Other Publications. Among the publications of value to this research are some which evaluate the cost allocation techniques detailed in CASB Standard 418 (8). Recall that Standard 418 includes a discussion of how to select a base for allocating costs. Recommended bases include direct labor hours, direct labor cost, machine-hours, units-of-production, and material cost. In a related publication called Government Contract Accounting, Bedingfield and Rosen have described the cost allocation techniques based on CASB's Standard 418:

> (i) A direct labor hour base or direct labor cost base shall be used, whichever in the aggregate is more likely to vary in proportion to the costs included in the cost pool being allocated, except that
>
> (ii) A machine-hour base is appropriate if the cost in the cost pool are comprised predominantly of facility-related costs, such as depreciation, maintenance, and utilities, or
>
> (iii) A units-of-production base is appropriate if there is common production of comparable units, or
>
> (iv) A material cost base is appropriate if the activity being managed or supervised is a material-related activity [4:8-57].

Similarly, in a 1983 issue of the National Estimator, Hassan described the previously mentioned bases for cost allocations and stated:

> Machine Hours. The first basis for applying overhead is machine hours. This technique is considered appropriate for companies which have a capital-intensive production process. However, determining the number of machine hours necessary to manufacture products is often relatively expensive when compared to other bases.
>
> Direct Labor Hours. When the production is labor intensive and the pay scale is based on seniority, direct labor hours may be used to apply overhead to products. This procedure will then result in an equitable allocation of overhead when calculating unit cost. However, determining the number of direct labor hours utilized in manufacturing products is often time-consuming and cost prohibitive.

Units Of Production. Companies which produce only one product or whose products have approximately the same volume or weight sometimes use units of production as the base for overhead application. However, if products take different amounts of time to produce or are different regarding weight or volume, the units or production base will yield an inequitable distribution of overhead to products, and therefore, an unrepresentative unit cost.

Direct Labor Cost. The most common method for overhead application is on the basis of direct labor cost. This method is appropriate when the production process is labor-intensive and employees receive the same wages for performing similar tasks...This technique will often provide the best estimate of overhead cost per product when considering both cost and theoretical factors.

Direct Materials Costs. Allocating overhead according to direct materials cost is theoretically unsound unless overhead costs are related directly to the usage of materials...However, it sometimes is used as a matter of expediency [29:12].

Hassan also points out that ordinarily, management's best choice in selecting a cost allocation basis will be the activity having a cause and effect relationship with production activity, and concurrently being relatively inexpensive to use. Hassan's summary remarks include, 'No single activity base is appropriate for all purposes. Management must select the one it deems most appropriate considering both cost and theoretical factors (29:12).

Based on a review of cost allocation techniques as viewed by Bedingfield and Rosen, Hassan, and as expressed by the Cost Accounting Standards Board, several possible cost allocation techniques are available and encouraged for use in the private sector and by government. Next, a review of the academic literature related to the theory of cost allocation techniques as used in this thesis is presented.

Academic Publications

Various indirect cost allocation issues have been written about in the accounting literature. For purposes of this paper, academic publications include a survey of textbooks, journals (of an accounting research nature), and research documents (i.e. thesises, reports, etc.) Comments will address both accounting theory and previous research that bears on this document.

Textbooks. Among the textbooks reviewed, The Allocation of Corporate Indirect Costs, written by Fremgen and Liao, focused on answering three important questions related to indirect cost allocations:

1. Can allocations ever be made reliable?
2. For what purposes should cost allocations be made or not be made?
3. On what bases should indirect costs be allocated?

In addressing each of these questions, Fremgen and Liao used a research approach unlike that found in most of the literature reviewed. From December 1979 to January 1980, they sent 766 questionnaires out and surveyed seven industries grouped as follows:

Number of Questionnaires	Industry
120	bank
66	conglomorates
60	insurance companies
90	retail firms
90	service companies
60	transportation firms
280	manufacturers

The results of this survey identified the industries' current cost allocation techniques and the rationale behind their use. Prior to discussing the results of the survey, it is important to address the review of literature on cost allocations presented by Fremgen and Liao.

The authors' literature review included a report on one of the most extensive and rigorous analysis of the validity of cost allocations. This was accomplished by Arthur L. Thomas who published two studies on the subject in 1969 and 1974. Thomas' conclusions were summarized as follows:

> Cost allocations are arbitrary and incorrigible. Allocations are arbitrary because they are necessarily made on the basis of someone's judgment as to how they should be made and not on the basis of some logical analysis of scientific evidence. They are incorrigible...because they can be neither proved correct nor rejected as incorrect. It is impossible to defend one particular allocation against all possible allocations of the same cost [25:9-10].

In his 1969 study, considered a classic in cost accounting, Thomas suggested that manufacturing overhead costs were commonly allocated to products on the basis of direct labor cost. He proposed that it was impossible to prove such an allocation any better than one which used prime cost, direct labor hours, or machine hours. Although he opposed allocations, Thomas identified the following minimum requirements for theoretical justification of an allocation method:

1. The method should be unambiguous.

2. It should be possible to defend the method.

3. The method should divide up what is available to be allocated, no more and no less. The allocation should be additive (39).

While Thomas was depicted as an opponent of allocations, Staubus was portrayed as an avid supporter of allocation methods. In their book, Fremgen and Liao report Staubus' views on allocations:

> Staubus said that the contention that all allocations are arbitrary is a myth. Rather, he (Staubus) suggested, there are good allocations and bad allocations. In general, if it is possible to measure the transfer of services from one activity to another in nonmonetary terms "with useful accuracy," it should be possible to measure the accompanying transfer of monetary value as well...If the physical transfer of services cannot be measured, any cost allocation would be bad and should be avoided [25:11].

Fremgen and Liao then turned their efforts to reviewing the literature which attempted to find out how costs were allocated and why. First, they expressed the view that the choice of allocation method should follow a definition of objectives and consistent criteria. They specified fairness or equity, benefit, cause, neutrality, independence of cost objectives, and ability to bear as the key criteria. Each criterion was explained as follows:

1. Fairness or equity - an intuitively appealing criterion because no one would argue for unfairness or inequity.

2. Benefit - a criterion where indirect costs are allocated based on what factors/operations received the benefit of the indirect costs. It is a more operational criterion than fairness but one that also depends on human judgment and which becomes more difficult to apply as the services become more remote from the cost objectives.

3. Cause - a criterion where indirect cost are allocated in proportion to whatever factor or factors cause those costs - if those causal factors are clearly identifiable in the cost objective to which the allocation is to be made.

4. Neutrality - the criterion favored especially by writers who question the validity of indirect cost allocations to begin with. It is intended to lead to the choice of allocation methods that avoid misleading information and, thus, prevent inappropriate decisions and inefficient disputes. Neutrality is a relative term.

5. Independence of cost objectives - this criterion asserts that the allocation method should be designed so that the cost allocated to one cost objective is not affected by the actions or events of other cost objectives during the period of the allocation.

6. Ability to bear - the criterion suggested only as the last alternative, when nothing better can be found. It leads to allocation on the basis of some measure of the size of the cost objectives.

Beyond the Fremgen and Liao analysis of the criteria cited above, each criterion has been addressed by different authors and publications. For example, the fairness or equity criterion was addressed in the <u>Defense Acquisition Regulations</u> and is identified as the basic criterion for allocating cost to defense contracts. Similarly, the benefit criterion was discussed by Wright and Bedingfield in a 1973 issue of the <u>Federal Accountant</u>. Their views were summarized in the discussion of benefit enumerated above. The criterion cause has also been written about extensively. Horngren supported this criterion and wrote on the subject in 1977. The same year the CASB also devoted some of their attempts at standardization with a publication that addressed cause. In 1978, the Boeing Company observed that "the cause of a cost is simply a reflection of the relationship between the cost and the cost objectives that benefit from it" (25:13-14). Neutrality was discussed by Moriarity in 1975. Moriarity proposed an allocation method that is neutral with respect to the decision on whether to provide a service jointly to two or more segments of a firm or to allow each segment to buy the service separately. He recommended that indirect costs of common services be allocated:

> ...by first charging each segment with the cost of obtaining its own services separately and then crediting each segment with a share of the total cost savings from common service in proportion to its separate costs. This way the cost allocated to any segment is always equal to or less than the cost of its next best alternative [25:14].

Moving on, Solomons addressed the topic of independence of cost objectives in 1965, while Horngren did so in 1977. Their philosophy was summarized earlier when the criteria were initially presented in this chapter. The final criterion, ability to bear was also discussed and supported by the CASB in 1977. Despite the fact that there is quite a bit of literature written on the criteria for cost allocations, Skousen recognized that criteria had to be established before management could choose acceptable allocation bases in accordance with those criteria (25:15). This point is vital to the selection of allocation bases as will be developed in this thesis.

Before reviewing some of the results of the Fremgen and Liao survey and other academic literature, it is important to note the objectives of indirect cost allocations. Fremgen and Liao reported four basic objectives of cost allocations:

1. Financial reporting.
2. Planning and decision making.
3. Pricing.
4. Control and performance evaluation.

Now that the hows and whys of cost allocations have been summarized from the theory as expressed by several authors, it is time to review the survey results presented in The Allocation of Corporate Indirect Costs. In their conclusion, Fremgen and Liao state:

> Despite the almost universal theoretical injunctions against allocating indirect costs, most companies do allocate them, at least for some purposes...most often for purposes of performance evaluation, yet, this is a purpose for which the theoretical literature argues that allocations are particularly inappropriate.
>
> ...One consequence of the widespread use of allocations, despite the problems of making them is a wide variety of practices, especially in the choice of allocation bases. No systematic patterns were observed in this study. It appears that allocation methods are selected because they are considered necessary, not because they appear to be uniquely appropriate in specific circumstances [25:73].

On the subject of the selection of allocation bases, the authors recognized that probably the most significant procedural problem in allocating indirect cost was the choice of an allocation base. Their survey tried to determine what criteria industries were using to select bases and then what bases were actually being used. Responses to the survey indicated that "factors that cause the indirect costs to be incurred and benefits received by profit centers were the most widely cited criteria" (25:74). In addition, only a few firms responded with the criteria that a profit center's abilitv to bear a share of indirect cost should be a factor in selecting the base for cost allocation. The authors' analysis of the bases used in industry included the following comments:

> ...the allocation bases that were actually being used more often suggested ability to bear than cause or benefit. In particular, when a single allocation base was used for all cost items and all purposes, it was usually a very broad measure of activity (such as sales, net assets, or total direct costs). Such a broad measure suggests that the allocation base is simply the size of each profit center, and size is clearly an indication of ability to bear, not of cause or benefit. Cause and benefit should lead to more specific allocation bases, such as the number of employees as a base for allocating personnel costs and computer time as a base for allocating costs of the data processing function...If a specific allocation base reflects factors that cause cost to be incurred, the allocation is more likely to be defensible. Conversely, if only a very general base can be found, the allocation may be of little value [25:75-76].

Another point of view concerning cost allocations is provided by Anthony and Young. In their textbook, <u>Management Control In Nonprofit Organizations</u>, they provide a detailed discussion of the cost accounting process. They describe four fundamental decision steps that organizations use to measure the total costs of resources used for a specific purpose. According to the authors, the measurement of these so called "full costs" of goods or services involves:

> decisions about the definition of a cost objective, the specification of cost centers, the distinction between direct and indirect costs, the choice of bases for allocating service center costs to other cost centers, the determination of a "stepdown" sequence, the method of assigning costs to cost objectives, and a choice between process and job order accounting [2:140].

An important analogy can be made between the accounting concept of allocating service center costs to other cost centers and the maintenance cost concepts being addressed in this thesis. The current technique of central stockage and issue of common supply items to various aircraft maintenance organizations neccessitates an allocation technique. As Anthony and Young would say, the central supply activity functions as a service center while the bench stock or the common items are the costs to be allocated from the service center to the other cost centers. Beyond being helpful in making this comparison, the authors provide an interesting view of the basis for cost allocations:

> ...the best basis for allocating the costs of each service center is the one that most accurately measures its use by other cost centers.
>
> ...In deciding on allocation bases, it is important to note that generally increased precision adds to the expense of the cost accounting system.
>
> ...The question of deciding on allocation bases depends in large part on the uses management will make of the information. If better information improves pricing decisions, or affects the organization's reimbursement from clients, or influences the behavior of people responsible for managing the cost centers, the extra expense may be worthwhile [2:140-141].

Anthony and Young's precautions will impact the decision of how the conclusions reached in this thesis will be implemented.

Other Publications. Among the more impressive academic publications reviewed was the encyclopedic study on the allocation of joint and common costs written by Biddle and Steinberg. In their 1984 report, published in the Journal of Accounting Literature, the authors critiqued and synthesized the major streams of cost allocation research previously done. Their work was designed to provide a framework for future research on cost allocations that would focus on how allocation methods should correspond to management decisions. Their work provides valuable insight by identifying bases for cost allocations and rationale for some of these bases.

Here is what the authors had to say on joint allocation practices:

> Traditionally, joint cost allocations have been based on information regarding either (1) physical proxies for benefits received from joint factors or (2) abilities to absorb costs. Many of the physical proxies appear to have been chosen for convenience -- examples include units of production, volumes, lengths, weights (including atomic weights), and heat contents. Since these measures will be correlated with economic costs only by chance, the resulting allocations are not likely to be neutral [5:11].

Biddle and Steinberg continue with a lengthy discussion of joint cost allocations based on economic theory and estimates of relative sales value. This discussion provides the rationale for cost allocations relative to the marginal revenue and marginal cost curves. The authors suggest that part of the process of allocating cost to joint products is the upper management decision to identify the optimal output mix (5:8-16).

Next, follows the authors' discussion of common cost allocations. Biddle and Steinberg provide a synopsis of two studies of common cost allocation practices. First, they discussed a study done by Mautz and Skousen in 1968 on noninventoriable common costs such as research and development, advertising, administrative and financing costs, and taxes. Of 412 firms studied (including 212 "Fortune 500" firms), 306 indicated that common costs were being allocated to divisions. Bases being used included division sales, assets or investments, and the number of employees. However, no rationale was reported for the use or choice of base.

Biddle and Steinberg also referred to the Fremgen and Liao study previously discussed in this chapter. The rationale for allocating costs was studied by Fremgen and Liao and reported by Biddle and Steinberg. In general, costs were allocated:

> ...to remind profit center managers that [common] costs exist and that profit center earnings must be sufficient to cover those costs...
>
> ...to fairly reflect each profit center's usage of essential common services [5:17].

Despite providing these two reasons for doing cost allocations, no rationale was reported on the choice of allocation base. This is consistent with the information previously reported by this author on Fremgen and Liao.

Next, Biddle and Steinberg discuss several common cost allocation proposals including ones by Moriarity (1975), Louderback (1976), Gangolly (1981), Balachandran and Ramakrishnan (1981). Each of these proposals is based on allocation methods for profit oriented activities. Additionally, authors of these proposals devoted rigorous mathematical treatment to their explanations. These treatments were extensive documentation of variants of the purely mathematical methodologies discussed earlier (i.e., linear programming, matrix theory, etc.) Thus, since bases and rationale for selecting bases were being sought, this section provided less utility to the topic of this research effort.

Subsequently, Biddle and Steinberg proceeded into a discussion of the history of game-theoretic approaches to cost allocations. The authors cite the works of Shapley (1953), Shubik (1962), Littlechild and Thompson (1977), and Verrechia (1981-82).

In concluding, Biddle and Steinberg assess the impact of cost allocation literature and the direction for future research. The principle conclusion is:

> A striking aspect of the cost allocation literature to date is its normative tone. Equally striking is the limited impact it has had on cost allocation practices. Foremost among research areas suggested by this study is a more thorough understanding of the motives for allocating costs [5:34-35].

Chapter Summary

The review of literature has been useful in providing several examples of cost allocation bases that may be used to generate the BMS cost factor. In addition, several statistical methodologies were identified which may be useful as this research continues into data analysis. Finally, the literature provided a basis for assessing the value of any new cost allocation method which may be developed in this thesis. Albeit, the common theme directly suggested by the authors, or as could be deduced from the literature, is that cost allocations need to be directly related to some appropriate cost driver. This theme must be kept in mind as this work develops or validates the BMS allocation base.

Based on the literature reviewed there is a variety of cost allocation bases. Among the military publications reviewed, GAO reported on two potential bases: the number of maintenance actions and direct labor hours. However, GAO's findings indicated that maintenance actions were understated by a factor of two, while direct labor hours were found overstated by a factor of two. These are important findings which may temper the decision to allocate costs based on maintenance actions and also suggest that the current base for allocating BMS costs, maintenance man-hours, may be questionable. Other examples of potential allocation bases were found in RAND reports. Novick suggested using flying hours as an allocation base, but did not provide strong justification. Conversely, Marks defined cause and effect relationships for maintenance material, provided meaningful rationale, and suggested maintenance actions as an allocation base. Other bases were suggested by the Cost Accounting Standards Board (CASB). Bedingfield and Rosen discussed rationale for five bases: direct labor hours, direct labor cost, machine-hours, units-of-production, and material cost. Hassan wrote additional rationale for CASB's allocation bases and proposed a hierarchy for using these bases. Table 3 summarizes the proposed allocation bases.

Table 3. Proposed Allocation Bases

Direct Labor Hours
Maintenance Actions
Flying Hours
Direct Labor Cost
Machine-Hours
Units-of-Production
Material Cost
Sorties
Primary Aircraft Authorized

Beyond the allocation bases reported, several statistical methods for allocating costs were found in the literature. Some of the purely mathematical methodologies reported included allocations based on matrix theory, linear programming, linear algebra, multiple correlation analysis, generalized least squares, and game theory. Variants to these methods were also discussed to show that nonquantitative factors could be considered. Surprisingly, Ayres points out that no one methodology has been adopted nor favored by users. Although several mathematical methodologies were reviewed, this paper will use multiple regression analysis to derive the allocation base.

Lastly, this chapter has attempted to provide a basis for assessing the value of any new cost allocation that may be developed in this research. The GAO studies and the Desmatics reports mentioned the need for reporting accuracy in the maintenance data that may be used for the allocation base. In fact, the contracted studies helped to validate the use of direct labor hours as an allocation base. Thus, the double check and follow on study of the cost estimating relationship developed in this thesis is in order. Equally important were the findings of Fremgen and Liao who not only provided an excellent review of the cost allocation literature to date, but also defined the criteria by which cost allocation bases should be selected. These criteria are fairness or equity, benefit, cause, neutrality, independence of cost objectives, and ability to bear. One final consideration useful in assessing the cost allocation models is the objective of the cost allocation. As Fremgen and Liao report, those objectives are financial reporting, planning and decision making, pricing, and control and performance evaluation. Each of these guidelines will be useful throughout this thesis.

IV. Research Methodology

Chapter Overview

This chapter describes and explains the methodology used in accomplishing the research. It begins by explaining how unallocated BMS costs occur and then defines the current BMS allocation method. Next, the hypothesis formulation is discussed, the actual research hypothesis is developed, and the methodology used to evaluate the research hypotheses is presented. More specifically, the research population and the sample from which the data are collected are defined. The chapter concludes with a discussion of the data collection method, the plan for data analysis, and explains how the results will be used.

How Unallocated BMS Costs Occur

In order to fully develop a comprehensive methodology for conducting research on the relationship between unallocated BMS costs and potential cost drivers, and thereby develop a means for allocating these BMS costs, it is necessary to explain how unallocated BMS costs occur. This section answers the first research question which is in two parts: "How are BMS costs determined and collected? What makes up the unallocated BMS costs?"

BMS costs are supply costs incurred for aircraft maintenance performed at base level. No costs are included for repairs that are depot funded. Depot funds are used to finance the more expensive, investment type, or structurally related repairs that can prolong the life of the weapon system. This is somewhat analogous to a new car owner. Small repairs that are done at home like replacing windshield wiper blades or a fan belt are done at the owners expense. This expense is equivalent to the BMS costs at base level. When the car owner needs a major repair, perhaps a transmission replacement, sizable expenditures occur and most times the repairs have to be done at a special shop. Some aircraft repairs work the same way. The transmission specialty garage is analogous to the Air Force depots. Only certain types of costs are recorded as BMS and these transactions are codified using specifically unique alpha and numeric symbols for both DOD and USAF. For example, DOD Element of Expense (DOD EE) codes are used to categorize financial transactions by commodity. In the Air Force, Element of Expense/Investment Codes (EEIC) are used to record the commodity transactions. Usually, these financial transactions are hierarchical in nature. That is, AF EEICs often summarize to DOD EEs.

Digressing to BMS, items are ordered through the base supply system for aircraft and, generally, parts can be ordered against specific aircraft using System Reporting Designator (SRD) codes. However, some items like bench stock (the nuts, bolts, small tools, and other parts that are common items from an accounting viewpoint), cannot be ordered against specific aircraft. Instead, these items are ordered against a specific maintenance organization

Usually the Chief of Maintenance account is used to record these costs.

Recall that a major management objective was directed for the services and implemented as VAMOSC. VAMOSC was designed to collect costs so that those who had a need for information about weapon systems could have a consolidated data repository. As a result of the current system, there is some degree of visibility of BMS costs, but only for the non-bench stock supply items. Since there is a need for an accountability of BMS cost in total by aircraft type, it is necessary to create some allocation method whereby these bench stock items could be charged against each type of aircraft. Thus, the development of BMS cost allocation algorithms now directed by AFR 400-31 (11; 43).

Current BMS Allocation Method

The second research question to be answered is: What procedure is currently used to allocate BMS costs to specific MDS aircraft?

AFR 400-31, Volume II describes the current BMS allocation method used in VAMOSC. Chapter Five, paragraph 5-7a describes the process as follows:

> (1) The below depot maintenance costs are extracted from the ABDS (USAF Standard Major Command Level Accounting and Budget Distribution System) and categorized and summarized...[11:38].

Paragraph 5-7a(3) discusses allocation of personnel strengths and various costs: "Both the costs and strengths are allocated to MDS using maintenance man-hours from the D056A (Base Man-hours Summary Interface File)" (11:38).

The BMS algorithm is described in AFR 400-31, Vol II, paragraph 5-7c. The algorithm is developed as follows:

> For each of the below depot maintenance functions, annual expenses are summarized by command, base, and category (material expense, contract, or other).
>
> Then...aircraft maintenance man-hours are summarized by command, base, and MDS [11:38].

For maintenance functions within each command/base and for each MDS, this allocation ratio is used:

$$AR = \frac{\text{Total Man-hours, this MDS}}{\text{Total Man-hours, all MDS}} \qquad (2)$$

where:

AR = Allocation Ratio

MDS = Aircraft mission, design, and series numbers at that base (i.e., T-37B, T-38A, etc.)

Inherent in the use of maintenance man-hours to allocate below depot maintenance costs, or the more familiar BMS costs, is the assumption that the distribution of maintenance costs is proportionate to the distribution of maintenance man-hours (11). This assumption is made in the regulation. During a July 1987 interview with Lt Col Wallace, he suggested that there is an implied assumption that one maintenance man-hour on one type of aircraft generates the same demand for supplies on another aircraft repaired by the same maintenance function (43). This thesis will focus on finding the appropriate BMS cost driver(s).

Both the guidance stipulated in AFR 400-31 and excerpts of the specific instructions and program processing sequences defined in the System/Subsystem Specification of the Weapon System Support Cost Subsystem (WSSC) DSD D160C are provided in Appendices A and B respectively. Readers desiring details on the allocation algorithms and data flow are referred specifically to Appendix B.

Hypothesis Formulation

The background developed in this thesis and the literature review served as the basis for identifying potential cost drivers which may then be used to allocate BMS costs following a statistical analysis and validation. Since the current method of allocating costs makes use of a ratio of maintenance man-hours per MDS to maintenance man-hours for all MDS, the hypothesis formulated for further investigation must be able to evaluate other cost drivers besides man-hours worked. In addition, the literature suggests that allocations for BMS costs, as well as other types of costs, must be impartial; flexible; reflect some causal relationship, benefit, or other surrogate measure; and stand the test of rigorous mathematical validation. In addition to these demands, data on the potential cost drivers should be relatively easy to obtain and, if possible, be available in some automated data base to allow ease of statistical manipulation.

Potential cost drivers are reported in Table 3 of the previous chapter. However, the cost drivers that will be evaluated in this thesis as possible bases for cost allocations are those which have been tracked in VAMOSC or are readily available at MAJCOMs. They include flying hours, sorties, primary aircraft authorized, and maintenance man-hours. Each of these was discussed in the literature review and based on discussions with Lt Col Wallace and other financial experts, each is a likely candidate to be a good cost driver for unallocated BMS costs (43).

Now that several potential allocation bases have been defined, it is logical to try to model the relationship between these bases and cost. Since regression analysis is a statistical tool which uses "the relation of two or more quantitative variables so that one variable can be predicted from the other, or others (33:23), it will be used to develop a model. Regression analysis techniques are not uncommon to the Air Force. AFR 173-13 requires the use of least squares regression analysis to compute attrition factors (peacetime flying losses) by MDS (19:106). Additionally, regression analysis is one of the techniques often used to allocate costs or to identify bases for cost allocations as mentioned in the literature review. This technique will be used to determine the best or strongest variable(s) which can be used to predict BMS costs. The variables so identified will be used in Eq (2).

Research Hypotheses

Answering the third research question will lead to the research hypothesis. The assumptions previously specified in Chapter 1 apply. Recall the third research question: What parameters besides maintenance man-hours might be used to allocate BMS costs?

In order to answer the question, the following research hypothesis is proposed:

$$H_0: \quad Y_{ubms} = b_0 + b_1X_{fh} + b_2X_{paa} + b_3X_{sf} + b_4X_{mmh} + b_5X_{dbms} + \epsilon_i$$

where:

H_0 = the hypothesis that unallocated aircraft maintenance costs exhibit the relationships and properties of a linear regression model of the following form (or some variant thereof)

Y_{ubms} = unallocated BMS cost by base

b_0, b_1, b_2, b_3, b_4, and b_5 are parameters to be determined by solving the model

X_{fh} = a known constant representing flying hours by base

X_{paa} = a known constant representing primary authorized aircraft by base

X_{sf} = a known constant representing sorties flown by base

X_{mmh} = a known constant representing maintenance man-hours by base

X_{dbms} = a known constant representing direct BMS cost by base

ϵ_i = a random error term with a mean $E(\epsilon_i)=0$ and variance $\sigma^2(\epsilon_i) = \sigma^2$

Population of Interest

The research population of interest is all the aircraft by MDS assigned to the Air Training Command (ATC). Although BMS cost factors and allocations are computed for every aircraft in the Air Force inventory, the population has been restricted to ATC due to the time constraints associated with conducting hypothesis testing for all possible regression models using 1 to 4 independent variables and over 100 aircraft. Hopefully, a regression model developed in this research will be generalizable to other Air Force aircraft, especially with like characteristics.

Hq AFLC/ACCE, the Office of VAMOSC, is responsible for maintaining data on weapon systems by MDS. Historical data is maintained for aircraft maintenance man-hours, flying hours, primary aircraft authorized, and base maintenance supplies costs. The population of interest in VAMOSC contains 306 observations, where one observation is counted for each base's BMS cost, flying hours, primary aircraft authorized by year (for FY 1981-86) and by command and MDS.

Sample Selection

From the given population, a stratified sample was extracted to obtain data for FY 84-86 for these ATC bases:

Laughlin AFB, Tx
Columbus AFB, Ms
Reese AFB, Tx
Vance AFB, Ok
Williams AFB, Az
Randolph AFB, Tx
Mather AFB, Ca
Sheppard AFB, Tx

These bases represent the flying training mission for ATC. In order to be included in the sample set, the ATC base had to conduct flying training in either the T-37B, T-38A, or the T-43 aircraft. Because only ATC training aircraft are reviewed, this sample is considered a stratified sample. Walizer and Wienir state that a stratified sample is a "procedure in which the population is separated into categories or strata prior to the selection of the elements" (41:436). The sampling technique used should contain a sufficient number of responses to be representative of the training aircraft BMS costs in ATC. The research is expected to adhere to Dominowski's views on sampling, "What is desired is a representative sample, one whose measurement will adequately represent the measurements in the population" (22:167).

Data Collection

Data like that in Table 4 were obtained from Hq AFLC/ACCE (VAMOSC) and LSMC/SMMA for this study. Table 4 shows a sample of the VAMOSC data used in this thesis. It was extracted from the Weapon System Support Cost (WSSC) subsystem of VAMOSC.

Table 4. Sample of VAMOSC Data

FISCAL YEAR	AIRCRAFT MDS	MAJOR COMMAND	GEOGRAPHIC LOCATION	PRIMARY AIRCRAFT AUTHORIZED	FLYING HOURS	BMS COSTS	BASE
81	T037B	ATC	EEPZ	97.30	45232	2764	COLUMBUS AFB, MS
82	T037B	ATC	EEPZ	96.03	50135	3143	COLUMBUS AFB, MS
83	T037B	ATC	EEPZ	97.75	49834	3986	COLUMBUS AFB, MS
84	T037B	ATC	EEPZ	95.98	49561	3997	COLUMBUS AFB, MS
85	T037B	ATC	EEPZ	91.20	46665	3425	COLUMBUS AFB, MS
86	T037B	ATC	EEPZ	83.39	42399	2783	COLUMBUS AFB, MS
81	[illegible]	[illegible]	ZZZZ	0	0	22	LAUGHLIN AFB, TX

Additionally, data on maintenance man-hours and sorties flown were obtained separately from the ATC Directorate of Cost (Hq ATC/ACC). ATC only provided sortie and maintenance man-hour data for FY 84-86. Prior to the statistical analysis, the data provided by VAMOSC was sorted by command and geographic location in order to obtain data by specific bases. Next a second sort was generated to select only the T-37B, T-38A, and T-43 aircraft. This resulted in sample size of 48 observations representing the eight ATC flying training bases and data for FY 81-86. A 24 observation sample (three years data for eight bases) was then extracted to match the sortie and maintenance man-hour data provided by ATC. This new data set is subsequently analyzed for consistency and regressed to help determine an appropriate cost driver for allocating the BMS costs.

Data Analysis Techniques

The procedures which will be used to analyze the data and that are addressed in this section include correlation matrix analysis, several regression techniques, and a variety of statistical tests.

Correlation Matrix. Initially, a correlation matrix is created with the data set to determine the correlation between the independent and dependent variables (BMS cost is the dependent variable) and to see how correlated the variables are with each other. Looking at the correlation matrix assists in determining which variables should be modeled. Generally speaking, the matrix can indicate whether independent and dependent variables are related significantly and can also give a preliminary indication of which independent variable would be first to enter a computerized regression model.

Regression Analysis Techniques. Three regression techniques will be addressed. First, concepts associated with least squares regression will be presented followed by a discussion of stepwise regressions. Finally, the analysis of variance (ANOVA) approach to regression is depicted. Each type of regression technique will be used at various stages of the research effort.

Least Squares Best Fit (LSBF). Concepts associated with the least squares method for fitting a regression line to a set of observed data are important to the analytical approach used in this effort. Recall from the research hypothesis above that a regression model of the form:

$$Y_{ubms} = b_0 + b_1X_{fh} + b_2X_{paa} + b_3X_{sf} + b_4X_{mmh} + b_5X_{dbms}$$

is the general model used to represent the relationship between cost drivers and unallocated BMS cost. Testing will be accomplished to determine the appropriate regression model and its parameters. The data provided for this thesis will be used to determine the parameter coefficients, b_0 - b_5, as needed. The method of least squares is a technique for finding good estimators of b_0 - b_5. In order to explain the procedure, the model $Y_{ubms} = b_0 + b_1X_{fh}$ will be discussed. According to Applied Linear Regression Models (33) then, for each sample observation (X_{fh}, Y_{ubms}), the method of least squares considers the deviation of Y_{ubms} from its expected value:

$$Y_{ubms} - (b_0 + b_1X_{fh})$$

LSBF requires that the sum of all the squared deviations of Y_{ubms} be a minimum. Using standard notation, the least squares criterion is denoted by Q:

$$\text{MIN} \quad Q = \sum(Y_i - B_0 - B_1X_1)^2 \tag{3}$$

The algebraic formulas for computing B_0 and B_1 are:

$$B_1 = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum(X_i - \bar{X})^2} \tag{4}$$

$$B_0 = \bar{Y} - b_1\bar{X} \tag{5}$$

where

B_1 = an estimator of the slope of the regression line

B_0 = an estimate of the y-intercept of the equation

X_i = the observed values of the independent variables

Y_i = all observed values of the dependent variable

$\bar{X}$ = the mean value of the independent variable

$\bar{Y}$ = the mean value of the dependent variable

<u>LSBF Example</u>. As principles of LSBF will be used in the analysis chapter, an example of how LSBF works is in order. A small data set, arbitrarily chosen by the researcher, will be analyzed.

Table 5 shows the algebraic computations for LSBF using these values for X_{fh} and Y_{ubms}:

X_{fh}	Y_{ubms}
1	3
2	7
3	8

Table 5. LSBF Sample Computations

X	Y	XY	X^2	Y^2
1	3	3	1	9
2	7	14	4	49
3	8	24	9	64
6	18	41	14	122

$$b = \frac{\text{Sum} [XY - n \bar{X}\bar{Y}]}{\text{Sum} [X^2 - n \bar{X}^2]}$$

$$b = \frac{41 - 3(2)(6)}{14 - 3(2)^2} = \frac{5}{2}$$

Estimating Equation:

$$\hat{Y}_{ubms} = 1 + 2.5X_{fh}$$

$$a = \bar{Y} - b\bar{X} = 6 - 2.5(2) = 1$$

Stepwise Regression. Although there are several techniques which can be used to perform regression analysis, the stepwise procedure described by Neter et al in Applied Linear Regression Models is used to initially specify models to be evaluated. Stepwise regression allows researchers to develop insights into the relationships between the independent variables and the dependent variable. Since it is used for "exploratory analysis," it is not guaranteed to give the best model for the data nor to provide the model with the highest R^2 (33). The following four stepwise regression techniques are proposed for analyzing the data:

1. Forward Selection - begins with no variables in the model and in an iterative process adds variables one by one based on satisfying an established F statistic criteria. The forward technique adds the variable which has the largest F statistic to the model.

2. Backward Elimination - begins by calculating statistics of a model including all the independent variables. Then variables are deleted one by one. Variables deleted are those showing the least contribution to the model as measured by the F value.

3. Stepwise - is similar to forward selection except that variables entered do not necessarily remain. Stepwise adds variables based on significant F value, searches all variables, and as needed deletes those that do not produce a significant F value.

4. Maximum R^2 Improvement - tries to find the best one-variable model, the best two-variable model, etc, even though it is not guaranteed to find the highest R^2 for each model type. In this technique, variables are added (based on their contribution to increasing the R^2), then compared to the variables not in the model to see if switching variables will further increase the R^2. This switching is a key difference from stepwise (33).

Each of these procedures will be used to statistically analyze the sampled data. The next regression procedure that is addressed is analysis of variance.

Analysis of Variance (ANOVA). ANOVA tables will also be produced to allow for comparison of the models and to evaluate the hypothesis tests. Table 6 shows the key elements of the ANOVA table. ANOVA tables supporting the findings in this research will be frequently analyzed.

Table 6. ANOVA Table

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square
Regression	$SSR = \sum(\hat{Y}_i - \bar{Y})^2$	p-1	$MSR = \frac{SSR}{p-1}$
Error	$SSE = \sum(Y_i - \hat{Y})^2$	n-p	$MSE = \frac{SSE}{n-p}$
Total	$SSTO = \sum(Y_i - \bar{Y})^2$	n-1	

ANOVA tables will be used to develop statistical tests to check for multicollinearity and also are an excellent source for summary statistics.

Statistical Tests. Once regression models have been identified, several statistical tests need to be conducted in order to properly evaluate the modeled data. This section will discuss tests of association for variables, the F statistic used to assess model linearity, the t statistic used to evaluate regression properties in variables and their coefficients, and finally will focus on aptness of model evaluations.

Coefficient of Multiple Determination (R^2) - R^2 measures how much variation in the dependent variable can be accounted for by the model. R^2 ranges in value from 0 to 1 and represents the ratio of the sum of squares for the model divided by the sum of squares for the corrected total. Said another way, as R^2 increases toward 1, the more the total variation of Y is reduced by introducing the independent variable X assuming all other X remain constant (33). Walizer and Wienir suggest ranges at Table 7 to allow researchers to assess the strength of the association between the independent variables and dependent variables using R^2.

Table 7. R^2 Association Measures (41:436)

Strength of Association	Appropriate Values of R^2
Weak	.15 or less
Moderately Weak	.16 - .30
Moderate	.31 - .41
Moderately Strong	.42 - .63
Strong	.64 or more

Neter *et al* defines the coefficient of multiple determination, or R^2, as follows:

$$R^2 = \frac{SSR}{SSTO} = 1 - \frac{SSE}{SSTO} \qquad (6)$$

where $0 \leq R^2 \leq 1$

and where

SSR = the regression sum of squares. It is a sum of squared deviations, each deviation being the difference between the fitted value of the regression line and the mean of the fitted values.

$$SSR = \sum(\hat{Y}_i - \bar{Y}_i)^2$$

SSE = the error sum of squares or residual sum of squares. If SSE = 0, all observations fall on the regression line. The larger the SSE, the greater the variation of the Y observations around the regression line.

$$SSE = \sum(Y_i - \hat{Y}_i)^2$$

SSTO = the total sum of squares. If SSTO = 0, all observations are the same. The greater the SSTO, the greater the variance among the Y observations.

$$SSTO = \sum(Y_i - \bar{Y})^2$$

R^2 = the coefficient of multiple determination and measures the proportionate reduction of the total variation in Y associated with the use of the set of variables $X_1, \ldots, X_{p-1}$ [33:241,422-423].

Neter et al suggest that since R^2 is a ratio of sums of squares and the denominator is constant for all possible regressions, R^2 varies inversely with SSE. However, SSE can never increase as additional independent variables are included in the model. Also, R^2 will be a maximum when all the potential variables are included in the model. In general the larger the R^2, the better the model fits the data. In evaluating the potential model, R^2 is a measure which will be reviewed to try to obtain as high a value as possible relative to the guides in Table 7.

Adjusted Coefficient of Multiple Determination - When looking at the R^2 statistic, caution should be used. As previously noted, the R^2 can be artificially increased as more independent variables are brought into the regression equation. Since this is true, the adjusted R^2 (R_a^2) value is also evaluated.

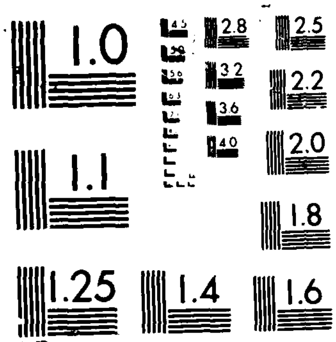
Neter defines the adjusted R^2, as follows:

$$R_a^2 = 1 - \frac{(n - 1)}{(n - p)} \frac{SSE}{SSTO}$$

where SSE, SSTO, n, and p are defined as before.

AD-A187 193 AN ALTERNATIVE METHOD FOR ALLOCATING BASE MAINTENANCE SUPPLIES TO MISSION..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST.. D F CORTEZ 2/2

UNCLASSIFIED SEP 87 AFIT/GSM/LSY/87S-7 F/G 5/3 NL


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

The R_a^2 may actually become smaller when another independent variable is introduced into the model because the decrease in SSE may be more than offset by the loss of a degree of freedom in the denominator n - p (33:242).

<u>F Value or F Ratio</u> - The F value is a ratio created by dividing the mean square of the model by the mean square for the error. The F test tells how well the model as a whole accounts for the behavior of the dependent variable. The value represents the ratio of the explained to the unexplained variation and is used to test the hypothesis that the regression coefficients are equal to zero. The reason for testing whether or not the regression coefficients are equal to zero is that when all the coefficients equal zero, there is no linear relationship between the dependent and independent variables. A large F value supports the conclusion that the dependent variable (in this case, the unallocated BMS costs) is related to the independent variables (perhaps one or a combination of: sorties, primary aircraft authorized, flying hours, and maintenance man-hours) in the regression equation.

Generally speaking, the F value is calculated using the observations in the sample and compared to a value obtained from a statistical table. Neter describes when to use the F test for regression relations:

To test whether there is a regression relation between the dependent variable Y and the set of variables $X_1, \ldots, X_{p-1}$, i.e., to choose between alternatives [33:240]:

$$H_0: \; B_1 = B_2 = \ldots = B_{p-1} = 0$$

$$H_A: \; \text{not all } B_k (k=1,\ldots,p-1) = 0$$

we use the test statistic:

$$F^* = \frac{MSR}{MSE} \tag{8}$$

where MSR and MSE are defined as before.

The decision rule used in conjunction with this F test is:

If $F^* \leq (1 - \alpha ; p - 1, n - p)$, Conclude H_0

If $F^* > (1 - \alpha ; p - 1, n - p)$, Conclude H_A

where

α = the confidence level; some fraction between 0 and 1 expressed as a decimal (e.g., a .95 confidence level means 95% of the time some condition is true; 5% of the time it is not.)

p = the number of X variables in the model

n = the number of observations in the sample (33:241)

For example, assuming a 95% confidence level, a set of seven observations which model a simple regression equation in one independent variable would produce the following table statistic for F:

$$F(\alpha; p, n-p) = F^*$$

$$F(.95; 1, 6) = 5.99$$

So in this case, the criterion for rejecting the hypothesis that the regression coefficients equal zero and that no linear relation between the X term(s) and Y exists is for the calculated F statistic to be greater than the table F statistic of 5.99.

<u>Prob ≥ F</u> - This statistic explains the significance of the regression equation and represents the probability of obtaining a larger F value if the independent variable(s) used equal zero. For purposes of evaluating the models and selecting a "best fit," this statistic will be not be calibrated because there is no guarantee that the potential cost drivers will be significant. Therefore the author will report the actual value of the model with the highest R^2 value and most significant Prob > F value. Then Walizer's association criteria will be used to draw conclusions about the strength of the model.

<u>T Statistic</u> - This statistic can be used to test several hypotheses concerning the parameter coefficients and also used to compute prediction intervals for estimates of the dependent variable. Neter <u>et al</u> gives a formula for the t-test used to see if individual regression coefficients equal zero. Thus, for the hypotheses:

$$H_0: B_1 = 0$$
$$H_A: B_1 \neq 0$$

$$t* = \frac{b_1 - B_{10}}{s(b_1)} \qquad (9)$$

where

t^* = the calculated t statistic

b_1 = the regression coefficient for X_1 of the sample

B_{10} = some specified nonzero value

$s(b_1)$ = the standard error of the estimate

The decision rule when controlling is:

If $|t^*| \leq t(1 - \alpha; n - p)$, Conclude H_0

If $|t^*| > t(1 - \alpha ; n - p)$, Conclude H_A

where $t(1 - \alpha; n - p)$ comes from a table. T tests will be conducted on potential models to assess if the intercept and other parameter coefficient values are significant. Note that if the intercept values prove insignificant, this t test suggests that the intercept can be assumed to equal zero. This helps simplify the form of the regression equation.

<u>Prob $\geq$ t</u> - This test statistic explains the significance of the parameter estimates in the regression equation. In this research project, the criteria for measuring the significance of a parameter and will be established at .80 as Neter suggests (33). As with the Prob > F, it is important to report the best model given the data set and selected potential cost drivers. However, Neter's criteria will be reviewed as conclusions are developed about the parameter coefficients.

<u>Aptness of Model Assessments</u>. Beyond the tests designed to measure the strength of the model in terms of its linearity, significance, and validity of parameter

estimates, analyses will evaluate the aptness of the model for the data. These analyses include:

1. Residual Analysis - Residuals are the difference between the observed value of the dependent variable and the fitted value expressed as the regression equation. Residuals are represented as the error term in regression equations and are denoted ϵ or e. Residual analysis will be used to check if the assumptions about the linearity of the model are correct, to see if there is consistency in the variation of the error terms (a property of regression equations), and to see if outliers are present. Residual analysis usually involves a graphic analysis. Figure 6 shows the systematic patterns of the residual plots that can be used to detect problems.

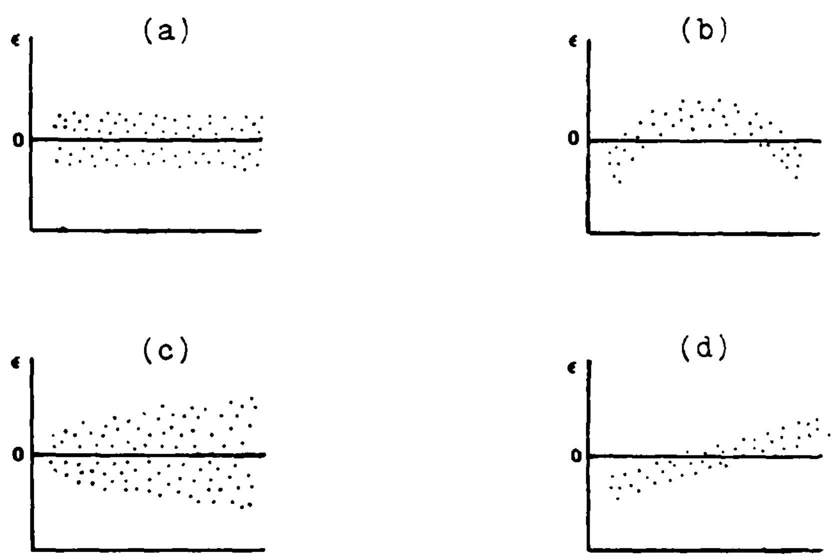


Figure 6: Residual Plots

Residual plot (a) in Figure 6 shows the schematic of the general shape of a plot of residuals if a linear model has been specified. In (b) there is an indication that a curvilinear regression function be used, while (c) shows a problem caused by an apparent nonconstancy of the error term variance which is depicted as increasing with X. Residual plots versus time, as shown in (d), suggest non-independence of error terms, or autocorrelation (another regression property is the error terms are independent). This plot may also suggest that an important variable, perhaps time, has been omitted from the regression model. In each of these cases the residuals have been plotted against an independent variable. Residuals can also be plotted against the observed value of the dependent variable (Y) in order to study the constancy of error variance. Thus, residual plots will be evaluated during the analysis of the sampled data.

<u>Outlier Evaluation</u> - Outliers are extreme observations and can be observed in residual plots. They are usually data points far beyond the plot of the other residuals. Outliers may be considered with respect to the independent variable (X) or the dependent variable (Y) or both X and Y. Outliers tend to draw the fitted regression line towards that extreme observation's X and/or Y value. Statistical tests which can be used to verify the presence and affect of outliers are discussed next.

1. <u>Outliers with respect to X</u> - beyond visual recognition of an outlier with respect to X, the leverage

value is computed to measure the distance of a given observation's location compared to the average value of all the other observations' X values. A large leverage value means that a given observation is located away from the center of the X values. The way to evaluate if the leverage value is significant is to compare it to the value of two times the number of parameters in the model divided by the total number of observations, or if the leverage is considerably larger than those of the other observations.

2. Outliers with respect to Y - Residuals can also show a Y value that is extreme or that is farther from the fitted regression line compared to the other Y values. The Studentized Deleted Residual value for each observation will be used to evaluate this condition. The absolute value of the studentized deleted residual is compared to the t statistic when the alpha value is set to .05 with n - 1 - p degrees of freedom, where n is the number of observations in the sample and p is the parameters in the model. One is subtracted from n because one observation is deleted from the sample in computing the studentized deleted residual. If the absolute value of the studentized deleted residual exceeds the value from the t table, then the observation is considered extreme with respect to Y and deserves further evaluation.

3. Influence Diagnostics - Once outliers are identified, they will be tested to see if they are influential in affecting the fitted regression line. Cook's

D is the statistic that will be used to evaluate an outliers for possible influence. When computed, Cook's D is compared to the value obtained for the F ratio for F(p, n - p) at a 50% level of confidence. If the computed Cook's D value exceeds the value of the F ratio, the observation is considered influential. An observation meeting this criteria can be influential with respect to X or Y or both depending on the observation's leverage value or studentized deleted residual value or both.

Multicollinearity - This is the condition that exists when the independent variables are correlated with themselves. Multicollinearity in a model can cause the regression coefficients to change, a lack of significance for individual independent variables despite the model being significant, and can cause variance in the extra sum of squares (extra sum of squares will be analyzed using ANOVA tables). The impact of multicollinearity can also be observed when a unit increase in a independent variable (X), given the other independent variables are held constant, may not produce as complete a change in the dependent variable as could have occurred if the other regression coefficients for the independent variables were not in the model. This suggests instability of the regression coefficients for the independent variables and suggests testing for collinearity.

Variance Inflation Factor (VIF). The variance inflation factor (VIF) is a way of detecting possible multicollinearity in a model by measuring the increase in the variances of the estimated regression coefficients when variables are added to the model. VIF is computed as:

$$VIF = \frac{1}{1 - R_k^2} \tag{10}$$

where

VIF = variance inflation factor

R_k^2 = the correlation of the identified variable with other model variables

Notice the denominator of the VIF equality. If VIF approaches 1, then no collinearity is indicated; while large values of the VIF indicate multicollinearity. Again, Neter suggests, if the VIF is greater than 10, multicollinearity is presumed to exist (33:392).

Each of the items identified in the section called Data Analysis Techniques must be evaluated in order to identify the best variable(s) related to cost. Once this is done the variable(s) will be applied to BMS cost allocation formula.

Integrating Findings into the Allocation Formula

If the regression model that best depicts the relationship to the unallocated BMS cost is a one variable model and the intercept, b_0, is not significantly different from 0 (Prob > t value is greater than .2) then the allocation formula would be the same as equation (2) except the new variable would be substituted for man-hours. However, if the appropriate model turns out to be multivariate and/or the intercept is significant, then the assumption must be made that the regression coefficients must be the same for all bases. Therefore the formula would have to be modified to allocate costs to each base based on this relationship:

$$Y_{ubms} = 1/N\ b_0 + b_1X_1 + \ldots + b_nX_n \qquad (11)$$

where

N = the number of MDS per base

Chapter Summary

This chapter presented the BMS allocation algorithm, the hypothesis development, the research hypothesis, and the methodology to be used for data analysis. Also discussed were the derivation of the population and sample data, and several statistical procedures. Initially, a correlation matrix will be used to try to determine which variables should be modeled. Then stepwise regression techniques will be used for an exploratory analysis of possible models. Then a variety of statistical tests will be conducted and ANOVA tables will be produced to help identify and select the "best" model. This model which will then be used to select an allocation base or bases and then recommend a change to the allocation calculation. Statistical results will be summarized in tabular form in Chapter V, Findings and Analysis.

V. Findings and Analysis

Chapter Overview

This chapter presents the data selected for analysis, describes the analyses performed, and presents the results of the efforts described in Chapter IV. In order, the data will be described, the correlation matrix and regression analyses will be discussed, and the results of the statistical testing will be presented.

Data Description

As previously mentioned, data for the analysis was provided by Hq AFLC/ACCE, LSMC/SMMA, and Hq ATC/ACC/ACB experts. This section describes the data in terms of the independent and dependent variables used to conduct the regression analyses.

Independent Variables. There were five independent variables selected for analysis in this thesis. The following are the variable names used in the regression runs and a brief description of what was included or meant by the data collected for each variable:

1. Primary Aircraft Authorized (PAA) - This actually was a surrogate measure for the number of aircraft assigned to each base. The source for this input was AFLC/ACCE (the VAMOSC Office). The reason this variable is considered a surrogate is because the actual data recorded in the VAMOSC subsystem is the possessed hours of each aircraft by base. At the end of the year, these possessed hours are

divided by the total number of hours per day times 365 days in a year. Thus, in this research project, PAA is actually a surrogate measure for the number of aircraft assigned to a base. Readers should understand that aircraft accountability is not a simple process of a base obtaining a certain number of airplanes to perform its flying mission for a year. Throughout the year, aircraft are loaned, shipped off to the air logistic centers in the Air Force for major repairs, or sent to participate in special missions where a commander does not have the aircraft available for use. Since an airbase's mission and readiness capability are directly associated with the number of available aircraft, the "possessed" system provides commanders with a truer picture of the readiness state of their wings and does not penalize them when aircraft are loaned, etc. Data on PAA was provided for all years and for every ATC base reviewed in this study. The data is rounded to two decimal places. PAA should show a positive relationship with the dependent variable, unallocated BMS cost because a greater need for bench stock and common type items is expected the more aircraft are possessed.

2. Flying Hours (FLYHRS) - For purposes of this study, flying hours are the aggregate number of hours flown by all aircraft at each ATC base. The information on FLYHRS was provided by experts at Hq ATC. Several cost analysts at ATC/ACC are responsible for maintaining weapon system data for the bases studied in this thesis. These analysts were

contacted by the researcher and provided the flying hour data used for this analysis. According to these analysts, all flying hour data were verified with the Operations Directorate at Hq ATC. Again, data were provided for all bases and all years. Flying hours were reported to the nearest hour. It was expected that as flying hours increased, so too would the amount of unallocated costs.

3. Sorties (SORTIES) - This variable measured the number of "trips" for all aircraft for the year. A sortie is counted each time a plane takes off for a mission, does not abort, and returns or lands at its destination point. Sorties were provided by Hq ATC cost analysts and were reported for all bases and all years. This complete data set was reported in whole numbers of sorties.

4. Maintenance Man-hours (MAINT_HR) - This is a compilation of the hours that represent the direct work performed on all aircraft at the bases. The numbers were reported by LSMC/SMMA and are reported in whole hours. They represent the sum of all the reported hours taken from the numerous AFTO Forms 349 discussed in Chapter II. Man-hours were reported for all years at all bases.

5. Direct Base Maintenance Supplies Cost (DBMSCOST) - Dollars reported for this variable were extracted from the VAMOSC data bases maintained by LSMC/SMMA programmers at Wright-Patterson AFB, Ohio. The dollars reported were the actual amounts for each fiscal year and base that related to the flying hour program for training in T-37, T-38, and T-43

aircraft. They represent the dollars that are used to perform organic maintenance on aircraft at the ATC bases. In the scheme of the current allocation algorithm for BMS costs, DBMSCOST represents the amount spent on aircraft maintenance by all maintenance activities except the Chief of Maintenance. Costs were provided for all bases and all years in then year dollars (those dollars actually spent in that year). These amounts were adjusted to base year 1986 constant dollars using the following conversion factors taken from the USAF Raw Inflation Indices issued 29 December 1986 (18):

Fiscal Year	Inflation Factor
84	.940
85	.972
86	1.000

Beyond the need to convert the dollars to a common base, it is expected that as direct maintenance expenditures increase so will the unallocated amount increase.

Dependent Variable. The dependent variable for this study is the unallocated base maintenance supplies cost, or UBMSCOST. Figures for UBMSCOST were also obtained from LSMC/SMMA and represent the cost of bench stock and common items not specifically attributed to aircraft by MDS and primarily accounted for in the Chief of Maintenance account. Dollars representing UBMSCOST were available for all years and all bases. However, the amounts were again provided in then year dollars and were then converted into 1986 base year dollars based on the inflation factors above. Table 8 shows the data provided for this research.

Table 8. Air Training Command BMS Data

YR	PAA	FLYHRS	SORTIES	MAINT_HR	DBMSCOST	BASE	UBMSCOST
84	189.22	98976	81001	1000878	12294652	COLUMBUS	80207
85	185.79	92618	76407	855416	10501973	COLUMBUS	136143
86	179.32	87828	70547	1594762	9328695	COLUMBUS	150022
84	191.93	99699	80675	1153400	12496517	LAUGHLIN	65707
85	185.11	93359	66047	680737	10010683	LAUGHLIN	95929
86	180.12	84649	61046	623762	8440706	LAUGHLIN	101186
84	68.83	36577	22151	393195	2103864	MATHER	78973
85	66.96	34390	20548	229362	1931722	MATHER	71710
86	50.79	22414	19920	307870	1502604	MATHER	84423
84	110.29	53652	44325	670959	10779860	RANDOLPH	1129516
85	106.36	46636	38002	456302	6258337	RANDOLPH	1513919
86	115.24	55709	45426	568547	6149872	RANDOLPH	311647
84	185.04	93784	77520	1069188	11180826	REESE	227377
85	175.61	88111	72610	501180	10375912	REESE	386781
86	172.77	83482	64236	958332	9064644	REESE	364558
84	169.27	81834	62257	595832	471197	SHEPPARD	120360
85	166.49	87551	66870	490035	633296	SHEPPARD	92602
86	167.03	86035	66920	573072	510524	SHEPPARD	43591
84	203.20	96809	79478	643668	9247398	VANCE	146996
85	197.23	96255	69421	486392	8833041	VANCE	156513
86	207.24	75905	75052	504593	5353440	VANCE	257528
84	183.49	100891	97468	1116482	13966793	WILLIAMS	99280
85	174.24	100921	69129	1057308	11488000	WILLIAMS	0
86	180.04	99578	80917	1071971	10560634	WILLIAMS	0

Analysis of Sample Data

Recall from Chapter IV that data were collected for all ATC bases which had a flying training mission. However, some bases had incompatible data and thus, were eliminated to produce a final sample data set. A subjective assessment and a statistical analysis were used to refine the data.

Subjective Analysis. Note that the ATC flying training program is represented by the bases shown in Table 8. However, Sheppard AFB Texas has a contractor operated maintenance function, and the type of aircraft maintenance performed was non-standard. Thus, this base was eliminated from consideration. This was done to preserve the homogeneity of the data set. A statistical analysis of the remaining data points was then accomplished.

Statistical Analysis. Once Sheppard was eliminated from the data set, the remaining 21 observations were reviewed again, this time using computer programs to perform residual analyses. Outliers were initially identified using the residual plots of each variable. Williams, Randolph, and Mather consistently appeared as outliers on the residual plots suggesting a more detailed analysis. Subsequently, leverage, studentized deleted residual (SDRESID), and Cook's D statistics were calculated for all one variable models created with the data set. Close analysis of these statistics and the values of the variables in the data set led to several findings.

Data inconsistencies were noted at all three bases. Specifically, Randolph had unusually high unallocated BMS costs in FY 84 and FY 85 ($1,129,516 and $1,513,919 compared to the FY 86 value of $311,647). Williams had similar inconsistencies for FY 85 and FY 86 data. No unallocated BMS costs were reported for those years implying that there were no expenses for bench stock supply items. Intuitively, this suggests that these costs are mixed in with the direct BMS costs figures. Notwithstanding, there is most likely an error in the recording of UBMSCOST at Williams for FY 85 and FY 86.

When the leverage and SDRESID values were evaluated, two bases (Randolph and Mather) reflected observations considered outliers to the data set. The outlier statistics are summarized in Table 9. Values in Table 9 are reported only where outlier statistics were indicated.

Table 9. Outlier Statistics for UBMSCOST

		Leverage		SDRESID		Cook's D	
Base	YR	Max	Act	Max	Act	Max	Act
Randolph	84	-	-	1.734	2.4705	.719	.2508
	85	-	-	1.734	4.8545	.719	.2513
	86	-	-	-	-	-	-
Mather	84	.1905	.2125	-	-	.719	.1751
	85	.1905	.2195	-	-	.719	.1955
	86	.1905	.2864	-	-	.719	.3412

All observations in Table 9 are outliers; however, based on the Cook's D statistics, none are influential. Neter suggests that outliers may be eliminated from the data set when influential. Although Randolph data are noninfluential outliers, the author concluded that the order of magnitude difference between fiscal years for UBMSCOST values indicated possible data reporting errors and resulted in Randolph's exclusion. Therefore, the author elected to remove Randolph from the data set, despite the Cook's D results. Notice also from Table 9 that FY 86 data was not problematic (no outlier indicated). In order to preserve data consistency, the author decided if any base's observations needed to be eliminated, all the observations for that base were eliminated.

Based on Table 9 and other knowledge of Mather, it was kept in the final data set. Although the outliers are not influential, the question remained, "Why does Mather show up as an outlier?" Since Mather is the primary ATC base for navigator training and is also the only base which uses the T-43 aircraft, its statistics are inconsistent with the other ATC bases. Thus, Mather is included in order to maintain the continuity of this research objective, that is identify a BMS cost allocation method for all aircraft MDS.

Lastly, Williams did not appear as an outlier based on a review of leverage, SDRESID, and Cook's D. However, based on the fact that no expenditures are indicated for FY 85 and FY 86, the author also decided to eliminate Williams from the data set.

The remaining 15 observations were expected to produce more significant results because of the elimination of Sheppard, Randolph, and Williams (this later proved to be true.) Next, a correlation matrix of all the variables was created and an analysis was conducted.

Correlation Matrix Analysis

Having selected and identified the variables to test using regression analysis, a correlation matrix was obtained to evaluate the assumption that each independent variable correlated positively with UBMSCOST. Below are the results of this analysis, displaying the independent variables, or the potential cost drivers, and each variable's coefficient of determination, R^2. Also, though there were positive coefficients of determination for the cost drivers, none of the values for R^2 indicated a strong relationship with UBMSCOST based on the Walizer association criteria:

Cost Driver	R^2	Strength of Association
PAA	0.1198	Weak
FLYHRS	0.0690	Weak
SORTIES	0.1167	Weak
MAINT_HR	0.0048	Weak
DBMSCOST	0.0503	Weak

At this point, the researcher developed a stepwise regression program to assess these variables and also to see if a regression model could be built. Initially, an F test significance level of 0.15 was selected as the criterion for allowing variables to enter the model. This significance level means that there is 85% confidence that the coefficients of the variables entering the model do not equal zero. Before describing what happened during the stepwise regression procedure, Table 10 displays the variables developed in this study and their corresponding R^2 values, F values, and Prob>F for the single variable and prior to any variable entering the stepwise regression model to attempt to define possible multivariate models.

Table 10. Variable Statistics Prior to Stepwise Entry

Variable	Model R^2	F Value	Prob>F
FLYHRS	0.0690	0.9633	0.3443
PAA	0.1198	1.7693	0.2063
SORTIES	0.1167	1.7179	0.2126
MAINT_HR	0.0048	0.0030	0.8058
DBMSCOST	0.0503	0.6889	0.4215

Stepwise Regression Results

Given the original variables, a stepwise regression program was applied to the data. At a 15% significance level, no variable met the criteria to be modeled. Therefore, the level of significance for entrance into the model was adjusted to 0.2, 0.3, and 0.4 in succession. During the successive runs, only two variables entered the model. Table 11 shows the variables that entered the model and the model R^2 values under the 0.2, 0.3, and 0.4 significance levels. Subsequent regression runs using both forward and backward elimination techniques were used to confirm the models suggested at the different significance levels. Both procedures produced identical results and are shown in Table 11.

Table 11. Stepwise Models at the 0.2, 0.3, and 0.4 Entry Significance Level

Significance Level	Variables In Entry Order	Model R^2
0.20	None	N/A
0.30	PAA	.1198
0.40	PAA FLYHRS	.1778

Thus, the stepwise regression suggests two models to express a relationship between UBMSCOST and the independent variables PAA and FLYHRS. However, these models are relatively weak as indicated by their R^2 value and significance level. These suggested models and one additional potential model are listed in Table 12 and will be further analyzed:

Table 12. Suggested Regression Models

	R^2	F Value	Prob>F	T Value	Prob>T	Parameter Estimate
Model A						
Intercept				.573	.5763	49,868.31
PAA	.1198	1.769	.2063	1.330	.2063	678.91
Model B						
Intercept				.855	.4080	76,502.73
FLYHRS	.0690	.963	.3443	.981	.3443	1.06
Model C						
Intercept				.691	.5027	61,066.97
PAA &	.1778	1.297	.3090	1.260	.2316	2,258.62
FLYHRS				-.920	.3758	-3.39

Model Statistical Analyses

Coefficient of Determination (R^2) Analysis. Both Models A and C were suggested by the stepwise technique. Model B is being analyzed in conjunction with the two-variable Model A. Additionally, each model's statistical strength and validity will be assessed. Since Model C has the strongest coefficient of multiple determination, R^2, it will be discussed first. Model C regressed FLYHRS and PAA against UBMSCOST and has an R^2 value of .1778. It is admittedly a weak model based on the Walizer criterion. However, Model C's R^2 value is larger than any of the one-variable models summarized in Table 10. Notice from Model A that when PAA alone is modeled, the R^2 value is .1198. The addition of FLYHRS into the model results in an increase of .0582 to R^2. This means that FLYHRS accounts for only a .0582 increase in explaining the variation from the regression line and does not significantly explain the variation from the regression line. Thus, it appears that PAA explains more of the variation.

F Statistic Analysis. Next, an analysis of the F values will help judge model linearity. As can be seen from Table 12, regression Model C has a F value of 1.297 and is statistically significant at the .3090 level of significance. Compared to Model A however, Model C is not as significant as Model A is. Model A, which regressed PAA individually, shows a higher F value and more favorable significance level than Model C (1.769 vs 1.297 and .2063 vs .3090 respectively). Therefore, when FLYHRS enters the model, the F value and Prob>F decline indicating that FLYHRS is not a significant variable for explaining unallocated BMS cost.

T Statistic Analysis. Now, the t statistics will be evaluated for the models. T-tests for both the parameter estimates and the intercepts will be addressed. Once again referring to Table 12, the variable PAA in Model A provides the most significant results. It's t value is 1.330 at the .2063 level of significance. This compares to PAA's t value of 1.260 at the .2316 level of significance in Model C. Recall that Model C includes both variables, PAA and FLYHRS. Reflecting again on Table 12, notice that the t statistic for FLYHRS has gone from a positive value of .981 in Model B to the negative value of -.920 in Model C. This seems to provide some "informal" evidence as Neter et al would say that serious multicollinearity exists (33:390). Formal analyses will assess multicollinearity later.

As suggested earlier, an analysis will be made of the intercepts for the proposed models to see if the intercepts can provide insights on the specification of the model. As a benchmark, if t statistics for the parameter estimates are not significant, there is a possibility that the value of the intercept is zero, thus passing through the origin on a Cartesian coordinate scale. This intuitively simplifies the regression equation and is appealing. Albeit, Model A's intercept value is least significant, compared to Models B and C, and is appealing in that there is a fairly good chance that the A's intercept equals zero based on its Prob>T value of .5763. Model C's intercept is a bit more significant at .5027. Model B's intercept is the most significant (.4080) indicating that it is the least likely of the three models to be zero.

Regression Coefficient Analysis. Another informal test for multicollinearity requires the analysis of the estimated regression coefficients, otherwise known as parameter estimates. Observing from Table 12, the parameter estimate for PAA in Model A is 678.91 and the value of the parameter estimate for PAA in the two-variable Model C is 2258.62. This is a significant difference and suggests possible multicollinearity.

Multicollinearity Analysis. Neter et al suggests that an analysis be done on the coefficients using the "extra sum of squares" (33:277-278). Table 13 provides the statistics for this analysis.

Table 13. Analysis of Extra Sum of Squares

(a) Regression of UBMSCOST on PAA and FLYHRS

$$\hat{Y} = 61066.97 + 2258.62\ X_1 - 3.39\ X_2$$

where: X_1 = PAA and X_2 = FLYHRS

Source of Variation		SS	df		MS
Regression	$SSR(X_1,X_2)$	26855061126	2	$MSR(X_1,X_2)$	13427530567
Error	$SSE(X_1,X_2)$	124213446202	12	$MSR(X_1,X_2)$	10351120517
Total	SSTO	151068507328	14		

(b) Regression of UBMSCOST on PAA

$$\hat{Y} = 49868.32 + 678.91\ \text{PAA}$$

Source of Variation		SS	df		MS
Regression	$SSR(X_1)$	18097606011	1	$MSR(X_1)$	18097606011
Error	$SSE(X_1)$	132970901318	13	$MSR(X_1)$	10228530871
Total	SSTO	151068507328	14		

(c) Regression of UBMSCOST on FLYHRS

$$\hat{Y} = 76502.73 + 1.06\ \text{FLYHRS}$$

Source of Variation		SS	df		MS
Regression	$SSR(X_2)$	10421589171	1	$MSR(X_2)$	10421589171
Error	$SSE(X_2)$	140646918157	13	$MSR(X_2)$	10818993704
Total	SSTO	151068507328	14		

Note from Table 13a that the error sum of squares (SSE) where both PAA and FLYHRS are included in the model is $SSE(X_1,X_2)$ = 124,213,446,202. When FLYHRS are included in the model, the $SSE(X_2)$ is equal to 140,646,918,157 as shown in Table 13c. Since the variation in Y when X_2 alone is considered is 140,646,918,157 but is 124,213,446,202 when both X_1 and X_2 are considered, the difference is attributed to the effect of X_1. Neter explains why:

> ...when two independent variables are uncorrelated, the marginal contribution of an independent variable in reducing the error sum of squares when the other independent variable is in the model is exactly the same as when this independent variable is in the model alone [33:274].

This leads to the following equation that allows further analysis of Table 13:

$$SRR(X_1|X_2) = SSE(X_2) - SSE(X_1,X_2) \qquad (12)$$

Application of Eq (12) to Table 13 results in:

26,855,061,126 = 140,646,918,157 - 124,213,446,202
26,855,061,126 $\neq$ 16,433,471,955

Empirical evidence is thus given to the existence of severe collinearity between the variables PAA and FLYHRS. In fact, the Pearson correlation coefficient (r) for these two variables is .9581 and results in a very strong relationship (R^2 = .92) between these two variables.

Another formal method of testing for multicollinearity is through an analysis of the Variance Inflation Factors

(VIF). In chapter IV, a criterion was described based on Neter:

> The largest $(VIF)_K$ among all X variables is often used as an indicator of the severity of multicollinearity. A maximum $(VIF)_K$ in excess of 10 is often taken as an indication that multicollinearity may be unduly influencing the least squares estimates [33:392].

Here are the Variance Inflation Factors resulting from special diagnostics requested for Model C in Table 12:

VARIABLE	VIF
PAA	12.1888
FLYHRS	12.1888

Once again, there is evidence of a strong correlation between PAA and FLYHRS. This collinearity undoubtedly influences the choice of the unallocated BMS cost models given in the original set of potential cost drivers and other findings in this analysis.

Research Conclusion

Stepwise regression analyses suggest these two models for evaluation:

Model A: UBMSCOST = 49868.32 + 678.91 PAA

Model C: UBMSCOST = 61066.97 + 2258.62 PAA - 3.39 FLYHRS

Detailed analysis and statistical testing were conducted on the coefficients of determination (R^2), F values and their significance, t values and their significance, intercept values and their significance, and the regression coefficient for all models. The analyses point to the existence of multicollinearity between the variables in

Model C and suggest the use of Model A as the model that best depicts a possible relationship with unallocated base maintenance supplies.

Due to the intuitive appeal of a simpler model and because of the insignificant value of the intercept term, the author suggests that Model A be reduced to Model D: $Y_{ubmscost} = 678.91\ X_{paa}$. This equation forces the intercept of the model through zero. This also simplifies the application of the regression model to the allocation ratio. Based on these results the application ratio would be based on PAA vice MAINT_HR as currently specified in AFR 400-31. Specifically, Model D coupled with the extremely low R^2 between MAINT_HR and UBMSCOST suggests this allocation algorithm as a substitute for the allocation algorithm for the chief of maintenance activities specified in AFR 400-31:

$$AR = \frac{\text{Total PAA, this MDS}}{\text{Total PAA, all MDS}} \tag{13}$$

An example of an allocation is presented to show the effect of the new allocation formula with PAA. Table 14 provides a sample calculation for Vance AFB for FY 86 using the current method and data from Table 8. The Vance allocation is then recomputed using the variable PAA as proposed by this study.

Table 14. Allocation of BMS Cost Example

Aircraft MDS	Maintenance Man-hours	Primary Aircraft Authorized
T-37B	248,798	116.98
T-38A	255,795	90.26
Total	504,593	207.24

Amount to allocate (UBMSCOST): $257,528

Current Allocation	Proposed Allocation
T-37B	**T-37B**
$\frac{248,798}{504,593} = .49307$	$\frac{116.98}{207.24} = .56447$
$257,528 x .49307 =	$257,528 x .56447 =
$126,978	$145,478
T-38A	**T-38A**
$\frac{255,795}{504,593} = .50693$	$\frac{90.26}{207.24} = .43553$
$257,528 x .50693	$257,528 x .43553
$130,549	$112,162

This example clearly shows a substantial change in cost allocations if PAA is used instead of maintenance man-hours as currently specified by regulation. Hopefully, future research endeavors will validate the findings in this thesis.

Finally, the results of this research do address an underlying question of this research: "Are maintenance man-hours a valid basis for allocating base maintenance supplies?" Empirically, the results show that maintenance man-hours are least related to the unallocated BMS cost.

Chapter Summary

The original data base for this research included observations for fiscal years 1984-86 for eight ATC bases. This data set was refined to exclude Sheppard, Williams, and Randolph AFB due to *a priori* and expert judgment about the expected relationships of four variables, inconsistencies in the data set most probably due to data errors, and because of a lack of homogeneity of maintenance functions (Sheppard was contractor operated).

The conclusions and recommendations chapter which follows highlights the significant findings of this research and suggests areas for further study.

VI. Conclusions and Recommendations

Chapter Overview

Chapter I described the research problem in detail; there is a need to improve the visibility of costs associated with weapon systems. More specifically, a study of the formulas used to distribute aircraft maintenance supply costs to specific aircraft was needed to determine whether or not base maintenance man-hours is a valid cost allocation base. An implied question of this research is whether an hour of work done on one type of aircraft causes the same demand level for supply consumption as for an hour of work done on another type of aircraft at the same base.

In order to address the specific problem, three things had to occur. First, the researcher had to assess potential cost drivers needed for investigations in this thesis. This was done by reviewing literature on cost allocations and also by consulting with experts in the Air Force financial community. Then, data needed to be located and obtained in order to conduct the research. The researcher used *a priori* judgment and expert opinion to select potential cost drivers and identify the data set to be analyzed. Finally, regression analysis was performed on the data set composed of data on Air Training Command's T-43, T-37, and T-38 aircraft in order to isolate a regression equation which establishes the strongest relationship between the cost drivers and unallocated base maintenance supplies.

Subsequently, the regression model was used to help validate or determine the need to modify the existing allocation algorithms. Three models were analyzed using a variety of statistical tests on the regression coefficients and intercept values. Model linearity was assessed, aptness of the model was evaluated, and collinearity testing was accomplished. The complete analysis of the regressed data lead to the conclusions and recommendations reported in this chapter.

Conclusions

Once the three models were analyzed completely, the researcher selected Model A as the best and most reasonable model for explaining unallocated base maintenance supplies cost as a function of the original potential cost drivers.

Here is the complete formula for Model A:

$$Y_{ubms} = 49868.31 + 678.91\ X_{paa} \qquad (14)$$

where

Y_{ubms} = unallocated BMS cost by base

X_{paa} = primary aircraft authorized by base

Since Model A had an insignificant t statistic for its intercept (indicating a strong probability of being 0), the researcher assumed that the intercept was indeed 0, and reduced Model A to Model D:

$$Y_{ubms} = 678.91\ X_{paa} \qquad (15)$$

Model D is intuitively more appealing and simplifies the process of applying its value to the allocation algorithm. A multivariate model is much more difficult to interpret and express in an allocation ratio because the application to an algebraic formula is not direct and no clear meaning can be given to the process.

Since Model D reflects data from only one MAJCOM and presents a small, representative sample of a very large and complex base aircraft maintenance supplies program, it is admittedly limited in scope. Also, the statistical testing indicates that a positive correlation exists between all the variables and unallocated BMS cost. However, it is never a very strong relationship and the regression models that were derived from the data set were all flavored with weak associations -- including Model D. In addition, the multiple variable models were handicapped by the existence of severe multicollinearity between the existing variables. Albeit, Model D has the strongest statistics of the regression models evaluated. Considering that the purpose in doing the regression was control, rather than prediction, this conclusion appears logical despite limitations and is meaningful in terms of considering an allocation base.

Another important conclusion is that of the five variables regressed and analyzed (individually and in combinations), maintenance man-hours consistently was the least statistically significant in terms of explaining unallocated BMS cost. Thus, empirical evidence is provided by this research to negate the use of maintenance man-hours as an allocation base. Additionally, the GAO findings referenced in the literature reviewed would support this conclusion (28).

Since the variables modeled did not produce highly significant results when regressed, two other conclusions are possible. First, there are potentially other variables that are significant cost drivers and could be evaluated. Perhaps, the number of aircraft engines or the weight of the aircraft are cost drivers and should be researched. Second, there is a strong possibility that the data set is erroneous. Recall that some of the VAMOSC data was eliminated because of suspected errors in reporting or recording.

Next, the application of Model D's results to the BMS allocation algorithm is summarized.

Applying the Conclusions

AFR 400-31 prescribes the allocation algorithm currently used to distribute the unallocated BMS costs. Based on the conclusion to use Model D, the allocation algorithm would become:

$$AR = \frac{\text{Total PAA, this MDS, this base}}{\text{Total PAA, all MDS, this base}} \qquad (16)$$

where all other terms are as before.

Finally, specific recommendations suggested by the conclusions and applications thereof are considered.

Recommendations

The author suggests four areas for further study based on the results of this research effort. First, direct follow-on research is needed to apply the methodology to other MAJCOMs. This way statistical results and conclusions can be compared for similarities and differences. Such a follow-on analysis may strengthen the credibility of this effort.

Second, the variables selected for this research were suggested by the literature in part, but were selected based on *a priori* judgment and expert opinion. Other variables for which data are tracked should be reviewed.

A third area where further study is suggested is a duplicate of this research in order to transform the original variables into potential cost drivers. Also, regression runs using interaction terms and indicator variables may provide statistically significant results that have greater utility than Model D.

Finally, a controlled experiment should be performed simultaneously throughout the Air Force to track issues of BMS supplies to maintenance activities and to specific MDS if possible. A three month effort is envisioned for these MAJCOMs: SAC, TAC, MAC, PACAF, and ATC. Additionally, each command would designate from one to three bases for study. The USAF Cost Center is suggested as the OPR for such a study. An informative data analysis could be accomplished using linear programming, goal programming, and regression analysis.

e. Remarks:

In FY 84 and for future years WSSC will use the Ammunition Reporting Management System (D078A) to determine actual cost of training munitions by command, MDS, and base. No allocation will be necessary.

5-7. Below Depot Maintenance Costs. This paragraph describes the processing for the cost and non-cost (numbers of personnel) elements of the Below Depot Maintenance portion of the AF History data base.

a. Process Description:

(1) The below depot maintenance costs are extracted from the ABDS and categorized and summarized as described in 5-7b(1) below.

(2) The average number of assigned personnel is determined from four quarterly extracts of the MPC data base (E300Z).

(3) Both the costs and the strengths are allocated to MDS using maintenance man-hours from D056A.

b. Input Data Elements:

(1) The dollar costs from the ABDS are selected and categorized using the parameters below.

(a) OAC—The Operating Agency Code is used in WSSC to identify command. For this process only records from the relevant commands are selected:

64—ATC	74—PAF
65—MAC	78—TAC
67—SAC	80—AFE
71—AAC	

(b) OBAN—The Operating Budget Account Number is used in WSSC to identify base within command. An OBAN to GELOC conversion table relates the OBAN codes of the ABDS to the GELOC (base) codes used in the MPC and D056A.

(c) RC/CC—The Responsibility Center/Cost Center codes of the ABDS are used in this process to identify the maintenance expense records to be selected. The selection codes and their categorization are listed below:

RC/CC	Function
XX20XX	Consolidated Aircraft Maintenance Squadrons (CAMS) Commander and Staff
XX21XX	Chief of Maintenance
XX22XX	Organizational Maintenance
XX23XX	Field Maintenance
XX24XX	Avionics Maintenance
XX25XX	Munitions Maintenance
XX2EXX	Equipment Maintenance
XX2GXX	Aircraft Generation
XX2RXX	Component Repair

(d) EEIC. The Element of Expense/Investment Code of the selected ABDS records is used to identify the nature of the expenses:

EEIC	Description
51XXX-59XXX	Contract Costs
60XXX-63XXX	Material expense
Remaining EEICs	Other costs

(2) Personnel strengths assigned to below depot maintenance functions are selected from the E300Z extract and categorized as follows:

(a) Command—Only relevant command strengths are selected. They are identified by the standard three position command codes (ADE MA-360): SAC, TAC, MAC, ATC, AAC, AFE, and PAF.

(b) GELOC—The base of assignment is identified in the MPC records by GELOC code (ADE GE-611).

(c) FAC—The following Functional Account Codes are used to identify all other below depot maintenance strengths:

FAC	Function
21XX*	Chief of Maintenance
22XX	Organizational Maintenance
23XX	Field Maintenance
24XX	Avionics Maintenance
25XX	Munitions Maintenance
2EXX	Equipment Maintenance
2GXX	Aircraft Operation
2RXX	Component Repair

* Records with FACs of 213X (ICBM Maintenance Training) and 214X (ICBM Technical Engineering) are excluded.

(3) Aircraft maintenance man-hours are extracted from the D056A according to the criteria below. This is a two step process, the first of which is accomplished by the D056A which builds a tailored output for WSSC:

(a) Command—Only man-hours expended by relevant commands are selected.

(b) GELOC—The base at which the maintenance is performed is identified on the D056A records by GELOC code.

(c) SRD—The Standard Reporting Designator is used by D056A to distinguish between aircraft maintenance man-hour records and those of man-hours expended on other types of equipment. Records with an SRD first position of "A" (Aircraft) or "X" (Engines) are selected. The D056A also translates the SRD code to aircraft MDS via a translation table (TO 00-20-2, attachment 2).

(d) Work Center Code (WCC)—The D056A abbreviates, to four positions, the five position code documented in the base level MDC system (TO 00-20-2, attachment 1). The first position is also changed to a constant "2". Records with the following D056A codes are selected:

WCC	Function
22XX	Organizational Maintenance
23XX	Field Maintenance
24XX	Avionics Maintenance
25XX	Munitions Maintenance
2EXX	Equipment Maintenance
2GXX	Aircraft Generation
2RXX	Component Repair

c. **Algorithm:**

(1) For each of the below depot maintenance functions, annual expenses are summarized by Command, Base, and category (material expense, contract, or other) using the parameters described in 5-7b(1) above.

(2) Assigned personnel strengths are averaged from the four E300Z extract files. For each of the below depot maintenance functions, average assigned strengths are summarized by command, base, and category using the parameters described in b(2) above.

(3) For each below depot maintenance function except chief of maintenance, aircraft maintenance man-hours are summarized by command, base and MDS using the parameters described in b(3) above.

(4) Within each command/base/below depot maintenance function (except chief of maintenance) represented in D056A, and for each MDS, a special allocation ratio (AR) is developed:

$$AR = \frac{\text{Man-hours, this MDS}}{\text{Total Man-hours, all MDS}}$$

(5) For the chief of maintenance function, within each command/base and for each MDS, the following allocation ratio is built:

$$AR = \frac{\text{Total Man-hours, all functions, this MDS}}{\text{Total Man-hours, all functions, all MDS}}$$

(6) The expenses and strengths of (1) and (2) above, for each command/base/maintenance function, are allocated to MDS using the corresponding allocation ratios.

NOTE: CAMS' commander and staff costs are treated as Chief of Maintenance costs.

d. **Assumptions and Constraints.** It is assumed that:

(1) Averaging the strength counts from four MPC extracts will provide a reasonable estimate of the average number of personnel assigned through the year.

(2) The GELOC code of the D056A records will always match the GELOC of the MPC records and the GELOC associated with the OAC/OBAN codes of the ABDS records.

(3) The distribution of maintenance costs and strengths is proportionate to the distribution of maintenance man-hours.

5-8. Installation Support. This paragraph describes the processing accomplished by the system to develop the various cost elements of the base level functions of real property maintenance, base communications, and base operations.

a. **Process Description.** Base level installation support costs are extracted from the ABDS. A share of the total of these costs is apportioned to aircraft support using personnel strength ratios. This share is further allocated to MDS based on flying hours and possessed hours.

b. **Input Data Elements:**

(1) Installation support costs are obtained from the ABDS and identified by the following data elements:

(a) *OAC/OBAN:* Each OAC and OBAN combination identifies the command and geographic location (Cmd/GELOC) of the record (via a translation table). In addition to the relevant commands, this process selects records from AFLC, AFSC, and AFCC:

OAC	Cmd	Code
63	AFLC	LOG
47	AFSC	SYS
49	AFCC	CSV

(b) *PEC:* All costs records will contain one of the following PEC codes:

XXX94—Real property maintenance costs

XXX95—Base communications costs funded by the host command at a base

XXX96—Base operations costs

33112*—Base communications costs funded by AFCC.

35114*—Air traffic control costs

* These records must also have RC/CC codes of XX26XX or XX38XX

(c) *EEIC:* Each record will have an EEIC code which generally identifies what the monies were spent for (such as pay, material, contract, or misc):

EEIC	Description
51XXX-59XXX	Contract
60XXX-63XXX	Material
Remaining EEICs	Other costs

Appendix B: WSSC Subsystem Specification

VISIBILITY AND MANAGEMENT

OF OPERATING AND SUPPORT COSTS

SYSTEM (VAMOSC)

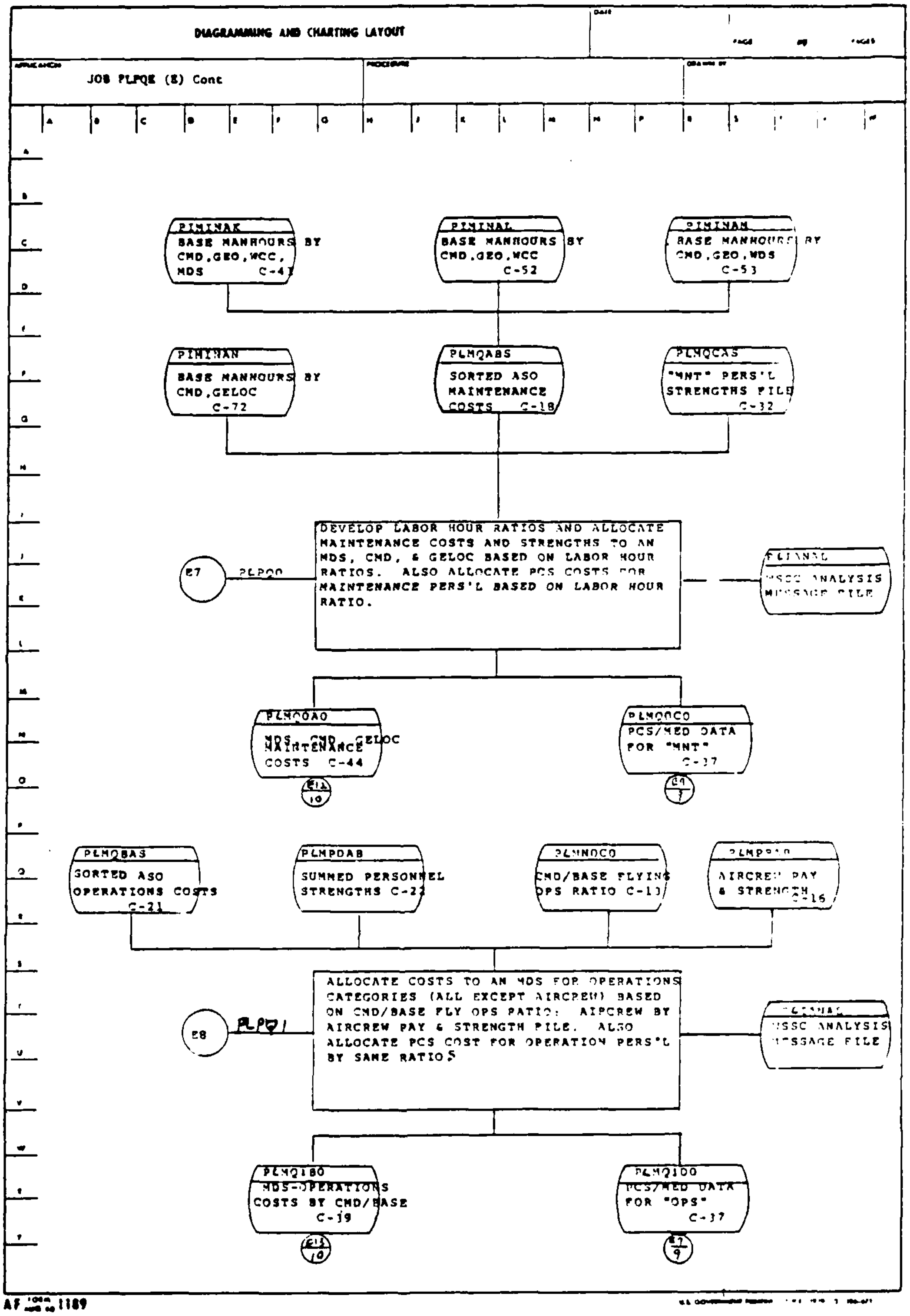
SYSTEM/SUBSYSTEM SPECIFICATION

OF THE WEAPON SYSTEM SUPPORT

COST SUBSYSTEM (WSSC)

DSD D160C

8 OCTOBER 1986


DIAGRAMMING AND CHARTING LAYOUT
JOB PLPQE (E) Cont
BASE MANHOURS BY CMD,GEO,WCC, MDS C-41
BASE MANHOURS BY CMD,GEO,WCC C-52
BASE MANHOURS BY CMD,GEO,MDS C-53
BASE MANHOURS BY CMD,GELOC C-72
PLMQABS
SORTED ASO MAINTENANCE COSTS C-18
PLMQCAS
"MNT" PERS'L STRENGTHS FILE C-32
DEVELOP LABOR HOUR RATIOS AND ALLOCATE MAINTENANCE COSTS AND STRENGTHS TO AN MDS, CMD, & GELOC BASED ON LABOR HOUR RATIOS. ALSO ALLOCATE PCS COSTS FOR MAINTENANCE PERS'L BASED ON LABOR HOUR RATIO.
E7
MSSC ANALYSIS MESSAGE FILE
MDS, CMD, GELOC MAINTENANCE COSTS C-44
PCS/MED DATA FOR "MNT" C-37
PLMQBAS
SORTED ASO OPERATIONS COSTS C-21
PLMPDAB
SUMMED PERSONNEL STRENGTHS C-22
CMD/BASE FLYING OPS RATIO C-13
AIRCREW PAY & STRENGTH C-16
ALLOCATE COSTS TO AN MDS FOR OPERATIONS CATEGORIES (ALL EXCEPT AIRCREW) BASED ON CMD/BASE FLY OPS RATIO. AIRCREW BY AIRCREW PAY & STRENGTH FILE. ALSO ALLOCATE PCS COST FOR OPERATION PERS'L BY SAME RATIOS
E8
PLPQ1
MSSC ANALYSIS MESSAGE FILE
MDS-OPERATIONS COSTS BY CMD/BASE C-39
PCS/MED DATA FOR "OPS" C-37
AF FORM 1189

4.4.4 PLPQ0 - Allocate Maintenance Costs based on Labor Hours Ratios.

a. Develop Labor Hour Ratios.

(1) Utilizing Base Manhours (CMD, GEO, WCC, MDS) Atch C-41 in seq. of CMD, GELOC, WCC & MDS and Base Manhours (CMD, GEO, WCC, blk MDS) Atch C-52 in seq. of CMD, GELOC, & WCC produce WCC Labor Hours Ratio File (C-43), developing ratio as follows:

$$\frac{\text{Hrs this MDS, by CMD/GELOC/WCC}}{\text{Hrs all MDS, by CMD/GELOC/WCC}} = \text{WC Labor Hour Ratio}$$

Also using Base Manhours (CMD, GELOC,(blk WCC), MDS) Atch C-53 in seq. of CMD, GELOC & MDS and Base Manhours (CMD, GELOC, (blk -WCC & blk-MDS)) Atch C-72 in seq. of CMD and GELOC develop a factor for the Chief of Maintenance activity and produce Chief of Maintenance Ratio records (write to C-43 above) developing ratio as follows:

$$\frac{\text{Hrs this MDS, by CMD/GELOC}}{\text{Hrs all MDS, by CMD/GELOC}} = \text{Chief Maint Labor Hour Ratio}$$

For data element, work center code on this file insert a "1" in all records for Chief of Maintenance Cost Category association.

(2) Using a COBOL Sort, sort C-43 and create Sorted WCC Labor Hours Ratio File (same format as C-43) in seq. of CMD, GELOC, MDS and WCC.

b. Build a Work File combining Costs and Strengths by Command and GELOC.

Read Sorted ASO Maintenance Costs record (C-18), one record per Command and GELOC, and move data elements to corresponding data elements in the Interim C-44 Work File (C-95). Read Maintenance Personnel Strengths record (C-32 format) and matching each personnel record to this work record being built on Command and GELOC move the No Off/Amn/Civ and Pay Off/Amn to 05 levels of related cost category per FAC as shown in the matrix below. (There will be multiple Personnel records per Command and GELOC, one for each WCC within FAC that has any personnel assigned.)

Manhours' WCC	Data Element Name on C-44 & C-95 Files	Personnels' FAC
1	Chief of Maint Costs	21X
2	Organizational Maint Costs	22X
3	Field Main Costs	23X
4	Avionics Maint Costs	24X
5	Munitions Maint Costs	25X
R	Component Repair Costs	2RX
E	Equipment Maint Costs	2EX
G	Aircraft Generation Sq. Costs	2GX

Produce Interim C-44 Work File (C-95). Close as Output.

c. Allocate Maintenance Costs and Personnel to an MDS.

Read Sorted WCC Labor Hours Ratio record (in format of C-43).

Read Interim C-44 work record (C-95), matching to Ratio records on Command and GELOC, apply WCC Labor Hours Ratio to the corresponding cost elements for each MDS within Command and GELOC. Reference the chart in paragraph b. (above) for WCC designations. Produce an output MDS, CMD, GELOC Maintenance Costs record (Atch C-44). File ID PLMQ0A0.

d. Move the ratioed No Off/Amn to a new work area (in format of C-37) as data elements 012 and 013, Medical Data Off/Amn. Total the ratioed No Off, No Amn and No Civ together for data element 014, Total Pers'l Strength. Also, using same WCC Labor Hours Ratios, allocate the PCS Cost Off/Amn (from C-32 record) to the new work area as data elements 010 and 011. Product output PCS/MED Data for "MNT" (C-37), by MDS, CMD, GELOC; PLMQ0C0.

e. For conditions to display on WSSC Analysis Message File see the maintenance manual for this program.

4.4.4.1 Inputs.

a. Base Manhours by CMD, GELOC, WCC, MDS.

(1) File ID: PIMINAK

(2) Record Layout: See Attachment C, Record Number 41

(3) Input Media: DUMTAPE

(4) Number of Records: 4,100/Annual

(5) Priority: Routine

(6) Retention Period: None

(7) Security: Unclassified

b. Base Manhours by CMD, GELOC, WCC (MDS blank)

(1) File ID: PIMINAL

(2) Record Layout: See Attachment C, Record Number 52

(3) Input Media: DUMTAPE

(4) Number of Records: 700/Annual

(5) Priority: Routine

(7) Security: Unclassified

c. Base Manhours by CMD, GELOC, MDS (WCC blank)

(1) File ID: PIMINAM

(2) Record Layout: See Attachment C, Record Number 53

(3) Input Media: DUMTAPE

(4) Number of Records: 2,500/Annual

(5) Priority: Routine

(6) Retention Period: None

(7) Security: Unclassified

d. Base Manhours by CMD, GELOC (WCC and MDS blank)

(1) File ID: PIMINAN

(2) Record Layout: See Attachment C, Record Number 72

(3) Input Media: DUMTAPE

(4) Number of Records: 300/Annual

(5) Priority: Routine

(6) Retention Period: None

(7) Security: Unclassified

e. Sorted ASO Maintenance Costs

(1) File ID: PLMQABS

(2) Record Layout: See Attachment C, Record Number 18

(3) Input Media: Disk

(4) Number of Records: 200/Annual

(5) Priority: Routine

(6) Retention Period: None

(7) Security: Unclassified.

f. Maintenance Personnel Strengths

(1) File ID: PLMQCAS

(2) Record Layout: See Attachment C, Record Number 32

(3) Input Media: Disk

(4) Number of Records: 7,500/Annual

(5) Priority: Routine

(6) Retention Period: None

(7) Security: Unclassified.

4.4.4.2 Outputs.

a. MDS, CMD, GELOC Maintenance Costs

(1) File ID: PLMQ0A0

(2) Record Layout: See Attachment C, Record Number 44

(3) Output Media: Disk

(4) Volume and Frequency: 2,100/Annual

(5) Priority: Routine

(6) Security: Unclassified

b. PCS/MED Data For MNT Personnel

(1) File ID: PLMQ0C0

(2) Record Layout: See Attachment C, Record Number 37

(3) Output Media: Disk

(4) Volume and Frequency: 2,100/Annual

(5) Priority: Routine

(6) Security: Unclassified

c. WSSC Analysis Message File

(1) File ID: PLIANAL

(2) Record Layout: Unique to each program

(3) Output Media: Printer

(4) Volume and Frequency: Variable/Annual

(5) Priority: Routine

(6) Security: Unclassified

(3) Output Media: Disk.

(4) Number of Records: 20,000.

(5) Retention: none

4.4.16 Program PIPIND160 - Produce Summary Files for Weapon System Support Cost (WSSC), for Monthly Base Maintenance Man-hours Summary. (Refer to Attachment D-16).

The Selected DO56A Man-hours, Attachment C-80, has been sorted and will be used as the input to the program on file PIIMAJ. This file is in sequence by Command (CMD), Geographic Location (GELOC), Work Center Code (WCC) and Model Design Series (MDS) and will be used to create four different levels of summary output records. Each level of summary will be written to a different file. Each type summary record will contain the summarized hours and count fields and will be in the format of Attachments C-56, C-57, C-58 and C-59. Depending upon the level of summarization, some of the control data will be excluded (fields will be blank). File PIMINAK will be summarized on CMD, GELOC, WCC and MDS. File PIMINAL will be summarized on CMD, GELOC and WCC with the MDS field blank. File PIMINAM will be summarized on CMD, GELOC and MDS with the WCC field blank. File PIMINAM will be summarized on CMD and GELOC with the WCC and MDS fields blank.

This program references Function 8, parpgraph 2.2.h.

4.4.16.1 Inputs

Selected DO56A Man-hours (sorted)

(1) File ID: PIIMAJ (sorted PIIILAG).

(2) Record Layout: Attachment C-80

(3) Input Media: Disk.

(4) Number of Records: 20,000.

(5) Retention: none

4.4.16.2 Outputs

a. Base Man-hour (Summarized to CMD, GELOC, WCC and MDS).

(1) File ID: PIMINAK.

(2) Record Layout: Attachment C-56.

(3) Output Media: Disk to DUMTAPE.

(4) Number of Records: 50,000.

(5) Retention: Three years.

b. Base Man-hours (Summarized to CMD, GELOC and WCC).

(1) File ID: PIMINAL.

(2) Record Layout: Attachment C-57.

(3) Output Media: Disk to DUMTAPE.

(4) Number of Records: 10,000.

(5) Retention: Three years.

c. Base Man-hours (Summarized to CMD, GELOC and MDS).

(1) File ID: PIMINAM.

(2) Record layout: Attachment C-58.

(3) Output Media: Disk to DUMTAPE.

(4) Number of Records: 5,000.

(5) Retention: Three years.

d. Base Man-hours (Summarized to CMD and GELOC).

(1) File ID: PIMINAN.

(2) Record Layout: Attachment C-59.

(3) Output Media: Disk to DUMTAPE.

(4) Number of Records: 2,500.

(5) Retention: Three years.

4.4.17 Program PIPIRD160 - Validate and Analyze Base Manhours Summary and Base On and Off Equipment (D056A, D056C). (Refer to Attachment D-17).

For this section there are three attachments that should help clarify the following narrative. Attachment G gives a very brief description for the meaning of selected codes found in the input records. Attachment H depicts into which counters the Labor Manhour field of the input will be added, depending on the combinations of the codes. Attachment I depicts which counts to increment by one when a given combination of codes exist. Both Attachments H and I, have a chart for both on and off data.

This program will process monthly. The program will edit and select data from the three interface files: Base Manhours Summary Interface File (D056A) Attachment C-55, which has had its manhours summarized for records with like control information, Attachment C-78, On Equipment Interface File (D056A), Attachment C-141/142 and C-84, and Off Equipment Interface File (D056C), Attachment C-143/144. In addition to the above interface files, two record types the AVA-GELOC/Base Name, Attachment C-113, and the BHA-Standard Reporting Designator, Attachment C-115, are read from the CSCS Table File. These two record types will be used to build two tables, the GELOC/Base Name and the Standard Reporting Designator. The tables will be used to help in the selection of the interface records, make determinations as to what is to be done with the interface records, and furnish data to build some data fields of the five outputs. The five outputs have document identifies, titles and attachment numbers as follows: GPA, Base Summary Record, Attachment C-86; GPB, Base MDS Summary, Attachment C-87; GPC, Base 2nd WUC Summary Record, Attachment C-88; GPD, Depot Summary Record, Attachment C-89; GPE, On/Off WUC for MDS/Base Summary Record, Attachment C-90.

SS-K-110580
D160C

ALIAS : PL109V3
MNEMONIC : D160C040005

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PLN A Q111A IFB PQ R##
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RECORD NAME : WSSC AF HISTORY
DOCUMENT IDENTIFIERS :
RECORD DESCRIPTION THIS RECORD IS DERIVED FROM THE PL109V3 RECORD.

MSTR ALIAS :

ELM NR	LVL NR	DATA ELEMENT LONG TITLE (FIRST 45 CHARS)	LOC RCD	PIC	COBOL DATA NAME	MNEMONIC	STID
1	01	WSSC AF HISTORY			WSSC-AF-HIST	D160C040005	
2	03	FISCAL YEAR	0001-0002	9(02)	FY-PL109V3	CDD0602656	
3	03	MISSION DESIGN AND SERIES IDENTIFICATION	0003-0009	X(007)	MDS-ID-PL109V3	CDD0500493	AE637
4	05	AEROSPACE VEHICLE STATUS PREFIX	0003-0003	A(01)	AV-CLSD-MSN-PL109V3	CDD0608047	DE860
5	05	AEROSPACE VEHICLE MODIFIED MISSION	0004-0004	A(01)	AV-MOD-MSN-PL109V3	CDD0606048	AU840
6	05	AEROSPACE VEHICLE BASIC MISSION	0005-0005	A(01)	AV-MSN-PL109V3	CDD0606054	A1640
7	05	AEROSPACE VEHICLE DESIGN NUMBER	0006-0008	X(003)	AV-DSGN-PL109V3	CDD0606219	AE632
8	05	AEROSPACE VEHICLE SERIES	0009-0009	A(01)	AV-SER-PL109V3	CDD0606220	AE697
9	03	POSSESSING COMMAND	0010-0012	A(03)	POSS-CMD-PL109V3	CDD0605498	MA360
10	03	GEOGRAPHICAL LOCATION INDICATOR	0013-0016	A(04)	GEOLOC-PL109V3	CDD0606430	GE611
11	03	RECORD IDENTIFIER	0017-0018	X(002)	RCD-ID-PL109V3	CDD0607964	
12	03	NUMBER OF POSSESSED AIRCRAFT	0019-0024	9(04)V9(02)	NR-POSS-ACFT-PL109V3	CDD0610360	
13	03	NUMBER OF ASSIGNED AIRCRAFT	0025-0029	9(05)	NR-ASGN-ACFT-PL109V3	CDD0610216	
14	03	AIRCRAFT POSSESSED HOURS	0030-0038	9(09)	ACFT-POSS-HR-PL109V3	CDD0606637	
15	03	FLYING HOURS	0039-0047	9(09)	FLY-HR-PL109V3	CDD0606683	
16	03	NUMBER OF CREWS	0048-0050	9(03)	NR-CREWS-PL109V3	CDD0606692	
17	03	AIRCREW COST	0051-0072	X(022)	ACRW-CST-PL109V3	CDD0500585	
18	05	OFFICERS PAY DOLLARS	0051-0056	9(06)	OFF-PAY-DOL-PL109V3	CDD0606715	
19	05	AIRMEN PAY DOLLARS	0057-0062	9(06)	AMN-PAY-DOL-PL109V3	CDD0606716	
20	05	NUMBER OF OFFICERS	0063-0067	9(05)	NR-OFF-PL109V3	CDD0606619	
21	05	NUMBER OF AIRMEN	0068-0072	9(05)	NR-AIRME-PL109V3	CDD0606620	
22	03	COMMAND STAFF COST	0073-0118	X(046)	CMD-STF-CST-PL109V3	CDD0500566	
23	05	MATERIAL COST	0073-0079	9(07)	MTL-CST-PL109V3	CDD0606795	
24	05	OTHER COST	0080-0085	9(06)	OTHR-CST-PL109V3	CDD0606980	
25	05	OFFICERS PAY DOLLARS	0086-0091	9(06)	OFF-PAY-DOL01-PL109V3	CDD0606715	
26	05	AIRMEN PAY DOLLARS	0092-0097	9(06)	AMN-PAY-DOL01-PL109V3	CDD0606716	
27	05	CIVILIANS PAY DOLLARS	0098-0103	9(06)	CIV-PAY-DOL-PL109V3	CDD0606717	
28	05	NUMBER OF OFFICERS	0104-0108	9(05)	NR-OFF01-PL109V3	CDD0606619	
29	05	NUMBER OF AIRMEN	0109-0113	9(05)	NR-AIRME01-PL109V3	CDD0606620	
30	05	NUMBER OF CIVILIANS	0114-0118	9(05)	NR-CIV-PL109V3	CDD0606621	
31	03	OTHER PERSONNEL COST	0119-0164	X(046)	OTHR-PERS-CST-PL109V3	CDD0500567	
32	05	MATERIAL COST	0119-0125	9(07)	MTL-CST01-PL109V3	CDD0606795	
33	05	OTHER COST	0126-0131	9(06)	OTHR-CST01-PL109V3	CDD0606980	
34	05	OFFICERS PAY DOLLARS	0132-0137	9(06)	OFF-PAY-DOL02-PL109V3	CDD0606715	
35	05	AIRMEN PAY DOLLARS	0138-0143	9(06)	AMN-PAY-DOL02-PL109V3	CDD0606716	
36	05	CIVILIANS PAY DOLLARS	0144-0149	9(06)	CIV-PAY-DOL01-PL109V3	CDD0606717	
37	05	NUMBER OF OFFICERS	0150-0154	9(05)	NR-OFF02-PL109V3	CDD0606619	
38	05	NUMBER OF AIRMEN	0155-0159	9(05)	NR-AIRME02-PL109V3	CDD0606620	
39	05	NUMBER OF CIVILIANS	0160-0164	9(05)	NR-CIV01-PL109V3	CDD0606621	
40	03	SECURITY COST	0165-0197	X(033)	SCTY-CST-PL109V3	CDD0500568	
41	05	OFFICERS PAY DOLLARS	0165-0170	9(06)	OFF-PAY-DOL03-PL109V3	CDD0606715	
42	05	AIRMEN PAY DOLLARS	0171-0176	9(06)	AMN-PAY-DOL03-PL109V3	CDD0606716	
43	05	CIVILIANS PAY DOLLARS	0177-0182	9(06)	CIV-PAY-DOL02-PL109V3	CDD0606717	
44	05	NUMBER OF OFFICERS	0183-0187	9(05)	NR-OFF03-PL109V3	CDD0606619	
45	05	NUMBER OF AIRMEN	0188-0192	9(05)	NR-AIRME03-PL109V3	CDD0606620	
46	05	NUMBER OF CIVILIANS	0193-0197	9(05)	NR-CIV02-PL109V3	CDD0606621	
47	03	PETROLEUM OIL AND LUBRICANTS COST	0198-0204	9(07)	POL-CST-PL109V3	CDD0606718	
48	03	GALLONS OF FUEL	0205-0214	9(10)	GAL-FUEL-PL109V3	CDD0610216	
49	03	TRAINING MUNITIONS COST	0215-0221	9(07)	TNG-MUN-CST-PL109V3	CDD0606723	
50	03	CHIEF OF MAINTENANCE COST	0222-0274	X(053)	CHF-MAINT-CST-PL109V3	CDD0500569	
51	05	MATERIAL COST	0222-0228	9(07)	MTL-CST02-PL109V3	CDD0606795	
52	05	CONTRACTOR COST	0229-0235	9(07)	CONTR-CST-PL109V3	CDD0606718	

ALIAS PL109V3
MNEMONIC D160C040005

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RECORD NAME : WSSC AF HISTORY
DOCUMENT IDENTIFIERS

MSTR ALIAS :

ELM NR	LVL NR	DATA ELEMENT LONG TITLE (FIRST 45 CHARS)	LOC RCD	PIC	COBOL DATA NAME	MNEMONIC	STID
53	05	OTHER COST	0236 0241	9(06)	OTHR CST02 PL109V3	CDD0606980	
54	05	OFFICERS PAY DOLLARS	0242 0247	9(06)	OFF PAY DOL04 PL109V3	CDD0606715	
55	05	AIRMEN PAY DOLLARS	0248 0253	9(06)	AMN PAY DOL04 PL109V3	CDD0606716	
56	05	CIVILIANS PAY DOLLARS	0254 0259	9(06)	CIV PAY DOL03 PL109V3	CDD0606717	
57	05	NUMBER OF OFFICERS	0260 0264	9(05)	NR OFF04 PL109V3	CDD0606619	
58	05	NUMBER OF AIRMEN	0265 0269	9(05)	NR AIRME04 PL109V3	CDD0606620	
59	05	NUMBER OF CIVILIANS	0270 0274	9(05)	NR CIV03 PL109V3	CDD0606621	
60	03	AVIONICS MAINTENANCE COST	0275 0327	X(053)	AV MAINT CST PL109V3	CDD0500571	
61	05	MATERIAL COST	0275 0281	9(07)	MTL CST03 PL109V3	CDD0606795	
62	05	CONTRACTOR COST	0282 0288	9(07)	CONTR CST01 PL109V3	CDD0606719	
63	05	OTHER COST	0289 0294	9(06)	OTHR CST03 PL109V3	CDD0606980	
64	05	OFFICERS PAY DOLLARS	0295 0300	9(06)	OFF PAY DOL05 PL109V3	CDD0606715	
65	05	AIRMEN PAY DOLLARS	0301 0306	9(06)	AMN PAY DOL05 PL109V3	CDD0606716	
66	05	CIVILIANS PAY DOLLARS	0307 0312	9(06)	CIV PAY DOL04 PL109V3	CDD0606717	
67	05	NUMBER OF OFFICERS	0313 0317	9(05)	NR OFF05 PL109V3	CDD0606619	
68	05	NUMBER OF AIRMEN	0318 0322	9(05)	NR AIRME05 PL109V3	CDD0606620	
69	05	NUMBER OF CIVILIANS	0323 0327	9(05)	NR CIV04 PL109V3	CDD0606621	
70	03	FIELD MAINTENANCE COST	0328 0380	X(053)	FLD MAINT CST PL109V3	CDD0500572	
71	05	MATERIAL COST	0328 0334	9(07)	MTL CST04 PL109V3	CDD0606795	
72	05	CONTRACTOR COST	0335 0341	9(07)	CONTR CST02 PL109V3	CDD0606719	
73	05	OTHER COST	0342 0347	9(06)	OTHR CST04 PL109V3	CDD0606980	
74	05	OFFICERS PAY DOLLARS	0348 0353	9(06)	OFF PAY DOL06 PL109V3	CDD0606715	
75	05	AIRMEN PAY DOLLARS	0354 0359	9(06)	AMN PAY DOL06 PL109V3	CDD0606716	
76	05	CIVILIANS PAY DOLLARS	0360 0365	9(06)	CIV PAY DOL05 PL109V3	CDD0606717	
77	05	NUMBER OF OFFICERS	0366 0370	9(05)	NR OFF06 PL109V3	CDD0606619	
78	05	NUMBER OF AIRMEN	0371 0375	9(05)	NR AIRME06 PL109V3	CDD0606620	
79	05	NUMBER OF CIVILIANS	0376 0380	9(05)	NR CIV05 PL109V3	CDD0606621	
80	03	MUNITIONS MISSILE MAINTENANCE COST	0381 0433	X(053)	MUN MSL MAINT CST PL109V3	CDD0500573	
81	05	MATERIAL COST	0381 0387	9(07)	MTL CST05 PL109V3	CDD0606795	
82	05	CONTRACTOR COST	0388 0394	9(07)	CONTR CST03 PL109V3	CDD0606719	
83	05	OTHER COST	0395 0400	9(06)	OTHR CST05 PL109V3	CDD0606980	
84	05	OFFICERS PAY DOLLARS	0401 0406	9(06)	OFF PAY DOL07 PL109V3	CDD0606715	
85	05	AIRMEN PAY DOLLARS	0407 0412	9(06)	AMN PAY DOL07 PL109V3	CDD0606716	
86	05	CIVILIANS PAY DOLLARS	0413 0418	9(06)	CIV PAY DOL06 PL109V3	CDD0606717	
87	05	NUMBER OF OFFICERS	0419 0423	9(05)	NR OFF07 PL109V3	CDD0606619	
88	05	NUMBER OF AIRMEN	0424 0428	9(05)	NR AIRME07 PL109V3	CDD0606620	
89	05	NUMBER OF CIVILIANS	0429 0433	9(05)	NR CIV06 PL109V3	CDD0606621	
90	03	ORGANIZATIONAL MAINTENANCE COST	0434 0486	X(053)	ORGN MAINT CST PL109V3	CDD0500574	
91	05	MATERIAL COST	0434 0440	9(07)	MTL CST06 PL109V3	CDD0606795	
92	05	CONTRACTOR COST	0441 0447	9(07)	CONTR CST04 PL109V3	CDD0606719	
93	05	OTHER COST	0448 0453	9(06)	OTHR CST06 PL109V3	CDD0606980	
94	05	OFFICERS PAY DOLLARS	0454 0459	9(06)	OFF PAY DOL08 PL109V3	CDD0606715	
95	05	AIRMEN PAY DOLLARS	0460 0465	9(06)	AMN PAY DOL08 PL109V3	CDD0606716	
96	05	CIVILIANS PAY DOLLARS	0466 0471	9(06)	CIV PAY DOL07 PL109V3	CDD0606717	
97	05	NUMBER OF OFFICERS	0472 0476	9(05)	NR OFF08 PL109V3	CDD0606619	
98	05	NUMBER OF AIRMEN	0477 0481	9(05)	NR AIRME08 PL109V3	CDD0606620	
99	05	NUMBER OF CIVILIANS	0482 0486	9(05)	NR CIV07 PL109V3	CDD0606621	
100	03	AIRCRAFT GENERATION SQUADRON COST	0487 0539	X(053)	ACFT GEN SQD CST PL109V3	CDD0500575	
101	05	MATERIAL COST	0487 0493	9(07)	MTL CST07 PL109V3	CDD0606795	
102	05	CONTRACTOR COST	0494 0500	9(07)	CONTR CST05 PL109V3	CDD0606719	
103	05	OTHER COST	0501 0506	9(06)	OTHR CST07 PL109V3	CDD0606980	
104	05	OFFICERS PAY DOLLARS	0507 0512	9(06)	OFF PAY DOL09 PL109V3	CDD0606715	
105	05	AIRMEN PAY DOLLARS	0513 0518	9(06)	AMN PAY DOL08 PL109V3	CDD0606716	

ALIAS : PL109V3
MNEMONIC : D160C040006

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RECORD NAME : WSSO AF HISTORY
DOCUMENT IDENTIFIERS :

MSTR ALIAS :

ELM NR	LVL NR	DATA ELEMENT LONG TITLE (FIRST 46 CHARS)	LOC RCD	PIC	COBOL DATA NAME	MNEMONIC	STID
106	05	CIVILIANS PAY DOLLARS	0519-0524	9(06)	CIV-PAY-DOL08-PL109V3	CDD0606717	
107	05	NUMBER OF OFFICERS	0525-0529	9(05)	NR-OFF09-PL109V3	CDD0606619	
108	05	NUMBER OF AIRMEN	0530-0534	9(05)	NR-AIRME09-PL109V3	CDD0606620	
109	05	NUMBER OF CIVILIANS	0535-0539	9(05)	NR-CIV08-PL109V3	CDD0606621	
110	03	COMPONENT REPAIR SQUADRON COST	0540-0592	X(053)	CMPNT-RPR-SQD-CST-PL109V3	CDD0500576	
111	05	MATERIAL COST	0540-0546	9(07)	MTL-CST08-PL109V3	CDD0606795	
112	05	CONTRACTOR COST	0547-0553	9(07)	CONTR-CST06-PL109V3	CDD0606719	
113	05	OTHER COST	0554-0559	9(06)	OTHR-CST08-PL109V3	CDD0606980	
114	05	OFFICERS PAY DOLLARS	0560-0565	9(06)	OFF-PAY-DOL10-PL109V3	CDD0606715	
115	05	AIRMEN PAY DOLLARS	0566-0571	9(06)	AMN-PAY-DOL10-PL109V3	CDD0606716	
116	05	CIVILIANS PAY DOLLARS	0572-0577	9(06)	CIV-PAY-DOL09-PL109V3	CDD0606717	
117	05	NUMBER OF OFFICERS	0578-0582	9(05)	NR-OFF10-PL109V3	CDD0606619	
118	05	NUMBER OF AIRMEN	0583-0587	9(05)	NR-AIRME10-PL109V3	CDD0606620	
119	05	NUMBER OF CIVILIANS	0588-0592	9(05)	NR-CIV09-PL109V3	CDD0606621	
120	03	EQUIPMENT MAINTENANCE SQUADRON COST	0593-0645	X(053)	EQP-MAINT-SQD-CST-PL109V3	CDD0500577	
121	05	MATERIAL COST	0593-0599	9(07)	MTL-CST09-PL109V3	CDD0606795	
122	05	CONTRACTOR COST	0600-0606	9(07)	CONTR-CST07-PL109V3	CDD0606719	
123	05	OTHER COST	0607-0612	9(06)	OTHR-CST09-PL109V3	CDD0606980	
124	05	OFFICERS PAY DOLLARS	0613-0618	9(06)	OFF-PAY-DOL11-PL109V3	CDD0606715	
125	05	AIRMEN PAY DOLLARS	0619-0624	9(06)	AMN-PAY-DOL11-PL109V3	CDD0606716	
126	05	CIVILIANS PAY DOLLARS	0625-0630	9(06)	CIV-PAY-DOL10-PL109V3	CDD0606717	
127	05	NUMBER OF OFFICERS	0631-0635	9(05)	NR-OFF11-PL109V3	CDD0606619	
128	05	NUMBER OF AIRMEN	0636-0640	9(05)	NR-AIRME11-PL109V3	CDD0606620	
129	05	NUMBER OF CIVILIANS	0641-0645	9(05)	NR-CIV10-PL109V3	CDD0606621	
130	03	BELOW DEPOT REAL PROPERTY MAINTENANCE COST	0646-0683	X(038)	BEL-DEP-RPM-CST-PL109V3	CDD0500549	
131	05	MATERIAL COST	0646-0652	9(07)	MTL-CST10-PL109V3	CDD0606795	
132	05	CONTRACTOR COST	0653-0659	9(07)	CONTR-CST08-PL109V3	CDD0606719	
133	05	OTHER COST	0660-0665	9(06)	OTHR-CST10-PL109V3	CDD0606980	
134	05	OFFICERS PAY DOLLARS	0666-0671	9(06)	OFF-PAY-DOL12-PL109V3	CDD0606715	
135	05	AIRMEN PAY DOLLARS	0672-0677	9(06)	AMN-PAY-DOL12-PL109V3	CDD0606716	
136	05	CIVILIANS PAY DOLLARS	0678-0683	9(06)	CIV-PAY-DOL11-PL109V3	CDD0606717	
137	03	BELOW DEPOT COMMUNICATIONS COST	0684-0721	X(038)	BEL-DEP-COMM-CST-PL109V3	CDD0500560	
138	05	MATERIAL COST	0684-0690	9(07)	MTL-CST11-PL109V3	CDD0606795	
139	05	CONTRACTOR COST	0691-0697	9(07)	CONTR-CST09-PL109V3	CDD0606719	
140	05	OTHER COST	0698-0703	9(06)	OTHR-CST11-PL109V3	CDD0606980	
141	05	OFFICERS PAY DOLLARS	0704-0709	9(06)	OFF-PAY-DOL13-PL109V3	CDD0606715	
142	05	AIRMEN PAY DOLLARS	0710-0715	9(06)	AMN-PAY-DOL13-PL109V3	CDD0606716	
143	05	CIVILIANS PAY DOLLARS	0716-0721	9(06)	CIV-PAY-DOL12-PL109V3	CDD0606717	
144	03	BELOW DEPOT BASE OPERATING SUPPORT COST	0722-0759	X(038)	BEL-DEP-BASE-OP-SPT-PL109V3	CDD0500561	
145	05	MATERIAL COST	0722-0728	9(07)	MTL-CST12-PL109V3	CDD0606795	
146	05	CONTRACTOR COST	0729-0735	9(07)	CONTR-CST10-PL109V3	CDD0606719	
147	05	OTHER COST	0736-0741	9(06)	OTHR-CST12-PL109V3	CDD0606980	
148	05	OFFICERS PAY DOLLARS	0742-0747	9(06)	OFF-PAY-DOL14-PL109V3	CDD0606715	
149	05	AIRMEN PAY DOLLARS	0748-0753	9(06)	AMN-PAY-DOL14-PL109V3	CDD0606716	
150	05	CIVILIANS PAY DOLLARS	0754-0759	9(06)	CIV-PAY-DOL13-PL109V3	CDD0606717	
151	03	REPLACEMENT SPARES COST	0760-0766	9(07)	REPL-SPAR-CST-PL109V3	CDD0606720	
152	03	MODIFICATION KITS MATERIAL COST	0767-0773	9(07)	MOD-KITS-MTL-CST-PL109V3	CDD0606721	
153	03	REPLACEMENT SUPPORT EQUIPMENT COST	0774-0780	9(07)	REPL-SPT-EQP-CST-PL109V3	CDD0606675	
154	03	AIRCRAFT OVERHAUL COST	0781-0812	X(032)	ACFT-OVHL-CST-PL109V3	D160C0500018	
155	05	MATERIAL COST	0781-0787	9(07)	MTL-CST13-PL109V3	CDD0606795	
156	05	CONTRACTOR COST	0788-0794	9(07)	CONTR-CST11-PL109V3	CDD0606719	
157	05	OTHER COST	0795-0800	9(06)	OTHR-CST13-PL109V3	CDD0606980	
158	05	AIRMEN PAY DOLLARS	0801-0806	9(06)	AMN-PAY-DOL15-PL109V3	CDD0606716	

ALIAS : PL109V3
MNEMONIC : D160C040005

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MSTR ALIAS :

ELM NR	LVL NR	DATA ELEMENT LONG TITLE (FIRST 45 CHARS)	LOC RCD	PIC	COBOL DATA NAME	MNEMONIC	STID
159	05	CIVILIANS PAY DOLLARS	0807-0812	9(06)	CIV-PAY-DOL14-PL109V3	CDD0606717	
160	03	ENGINE OVERHAUL COST	0813-0844	X(032)	EOH-CST-PL109V3	D160C0500001	
161	05	MATERIAL COST	0813-0819	9(07)	MTL-CST14-PL109V3	CDD0606795	
162	05	CONTRACTOR COST	0820-0826	9(07)	CONTR-CST12-PL109V3	CDD0606719	
163	05	OTHER COST	0827-0832	9(06)	OTHR-CST14-PL109V3	CDD0608980	
164	05	AIRMEN PAY DOLLARS	0833-0838	9(06)	AMN-PAY-DOL18-PL109V3	CDD0606716	
165	05	CIVILIANS PAY DOLLARS	0839-0844	9(06)	CIV-PAY-DOL15-PL109V3	CDD0606717	
166	03	ENGINE ACCESSORIES COST	0845-0876	X(032)	ENG-ACCS-CST-PL109V3	D160C0500002	
167	05	MATERIAL COST	0845-0851	9(07)	MTL-CST15-PL109V3	CDD0606795	
168	05	CONTRACTOR COST	0852-0858	9(07)	CONTR-CST13-PL109V3	CDD0606719	
169	05	OTHER COST	0859-0864	9(06)	OTHR-CST15-PL109V3	CDD0608980	
170	05	AIRMEN PAY DOLLARS	0865-0870	9(06)	AMN-PAY-DOL17-PL109V3	CDD0606716	
171	05	CIVILIANS PAY DOLLARS	0871-0876	9(06)	CIV-PAY-DOL16-PL109V3	CDD0606717	
172	03	AIRCRAFT ACCESSORIES COST	0877-0908	X(032)	ACFT-ACCS-CST-PL109V3	D160C0500003	
173	05	MATERIAL COST	0877-0883	9(07)	MTL-CST16-PL109V3	CDD0606795	
174	05	CONTRACTOR COST	0884-0890	9(07)	CONTR-CST14-PL109V3	CDD0606719	
175	05	OTHER COST	0891-0896	9(06)	OTHR-CST16-PL109V3	CDD0608980	
176	05	AIRMEN PAY DOLLARS	0897-0902	9(06)	AMN-PAY-DOL18-PL109V3	CDD0606716	
177	05	CIVILIANS PAY DOLLARS	0903-0908	9(06)	CIV-PAY-DOL17-PL109V3	CDD0606717	
178	03	AVIONICS INSTRUMENTATION COST	0909-0940	X(032)	AV-INSTR-CST-PL109V3	D160C0500004	
179	05	MATERIAL COST	0909-0915	9(07)	MTL-CST17-PL109V3	CDD0606795	
180	05	CONTRACTOR COST	0916-0922	9(07)	CONTR-CST15-PL109V3	CDD0606719	
181	05	OTHER COST	0923-0928	9(06)	OTHR-CST17-PL109V3	CDD0608980	
182	05	AIRMEN PAY DOLLARS	0929-0934	9(06)	AMN-PAY-DOL19-PL109V3	CDD0606716	
183	05	CIVILIANS PAY DOLLARS	0935-0940	9(06)	CIV-PAY-DOL18-PL109V3	CDD0606717	
184	03	AVIONICS COMMUNICATION COST	0941-0972	X(032)	AV-COMM-CST-PL109V3	D160C0500005	
185	05	MATERIAL COST	0941-0947	9(07)	MTL-CST18-PL109V3	CDD0606795	
186	05	CONTRACTOR COST	0948-0954	9(07)	CONTR-CST16-PL109V3	CDD0606719	
187	05	OTHER COST	0955-0960	9(06)	OTHR-CST18-PL109V3	CDD0608980	
188	05	AIRMEN PAY DOLLARS	0961-0966	9(06)	AMN-PAY-DOL20-PL109V3	CDD0606716	
189	05	CIVILIANS PAY DOLLARS	0967-0972	9(06)	CIV-PAY-DOL19-PL109V3	CDD0606717	
190	03	AVIONICS NAVIGATION COST	0973-1004	X(032)	AV-NAV-CST-PL109V3	D160C0500006	
191	05	MATERIAL COST	0973-0979	9(07)	MTL-CST19-PL109V3	CDD0606795	
192	05	CONTRACTOR COST	0980-0986	9(07)	CONTR-CST17-PL109V3	CDD0606719	
193	05	OTHER COST	0987-0992	9(06)	OTHR-CST19-PL109V3	CDD0608980	
194	05	AIRMEN PAY DOLLARS	0993-0998	9(06)	AMN-PAY-DOL21-PL109V3	CDD0606716	
195	05	CIVILIANS PAY DOLLARS	0999-1004	9(06)	CIV-PAY-DOL20-PL109V3	CDD0606717	
196	03	ARMAMENT COST	1005-1036	X(032)	ARM-CST-PL109V3	D160C0500007	
197	05	MATERIAL COST	1005-1011	9(07)	MTL-CST20-PL109V3	CDD0606795	
198	05	CONTRACTOR COST	1012-1018	9(07)	CONTR-CST18-PL109V3	CDD0606719	
199	05	OTHER COST	1019-1024	9(06)	OTHR-CST20-PL109V3	CDD0608980	
200	05	AIRMEN PAY DOLLARS	1025-1030	9(06)	AMN-PAY-DOL22-PL109V3	CDD0606716	
201	05	CIVILIANS PAY DOLLARS	1031-1036	9(06)	CIV-PAY-DOL21-PL109V3	CDD0606717	
202	03	SUPPORT EQUIPMENT COST	1037-1068	X(032)	SE-CST-PL109V3	D160C0500008	
203	05	MATERIAL COST	1037-1043	9(07)	MTL-CST21-PL109V3	CDD0606795	
204	05	CONTRACTOR COST	1044-1050	9(07)	CONTR-CST19-PL109V3	CDD0606719	
205	05	OTHER COST	1051-1056	9(06)	OTHR-CST21-PL109V3	CDD0608980	
206	05	AIRMEN PAY DOLLARS	1057-1062	9(06)	AMN-PAY-DOL23-PL109V3	CDD0606716	
207	05	CIVILIANS PAY DOLLARS	1063-1068	9(06)	CIV-PAY-DOL22-PL109V3	CDD0606717	
208	03	CLASS IV MODIFICATION INSTALLATION COST	1069-1077	9(09)	CLS-IV-MOD-INSTL-CST-PL109V3	CDD0610217	
209	03	INTERIM CONTRACTOR SUPPORT COST	1078-1086	9(09)	ICS-CST-PL109V3	CDD0610218	
210	03	CONTRACTOR LOGISTICS SUPPORT COST	1087-1095	9(09)	CLS-CST-PL109V3	CDD0610219	
211	03	REAL PROPERTY DEPOT LEVEL MAINTENANCE COST	1096-1133	X(038)	REAL-PPTY-DLM-CST-PL109V3	CDD0800562	

ALIAS : PL109V3
MNEMONIC : D160C040006

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PCN : A-Q111A-IFB-PQ-RXA

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MSTR ALIAS :

ELM NR	LVL NR	DATA ELEMENT LONG TITLE (FIRST 45 CHARS)	LOC-RCD	PIC	COBOL DATA NAME	MNEMONIC	STID
212	05	MATERIAL COST	1096-1102	9(07)	MTL-CST22-PL109V3	CDD0606795	
213	05	CONTRACTOR COST	1103-1109	9(07)	CONTR-CST20-PL109V3	CDD0606719	
214	05	OTHER COST	1110-1115	9(06)	OTHR-CST22-PL109V3	CDD0606980	
215	05	OFFICERS PAY DOLLARS	1116-1121	9(06)	OFF-PAY-DOL15-PL109V3	CDD0606715	
216	05	AIRMEN PAY DOLLARS	1122-1127	9(06)	AMN-PAY-DOL24-PL109V3	CDD0606716	
217	05	CIVILIANS PAY DOLLARS	1128-1133	9(06)	CIV-PAY-DOL23-PL109V3	CDD0606717	
218	03	COMMUNICATIONS DEPOT LEVEL MAINTENANCE COST	1134-1171	X(038)	COMM-DLM-CST-PL109V3	CDD0500553	
219	05	MATERIAL COST	1134-1140	9(07)	MTL-CST23-PL109V3	CDD0606795	
220	05	CONTRACTOR COST	1141-1147	9(07)	CONTR-CST21-PL109V3	CDD0606719	
221	05	OTHER COST	1148-1153	9(06)	OTHR-CST23-PL109V3	CDD0606980	
222	05	OFFICERS PAY DOLLARS	1154-1159	9(06)	OFF-PAY-DOL16-PL109V3	CDD0606715	
223	05	AIRMEN PAY DOLLARS	1160-1165	9(06)	AMN-PAY-DOL25-PL109V3	CDD0606716	
224	05	CIVILIANS PAY DOLLARS	1166-1171	9(06)	CIV-PAY-DOL24-PL109V3	CDD0606717	
225	03	DEPOT BASE OPERATIONS COST	1172-1209	X(038)	DEP-BASE-OP-CST-PL109V3	CDD0500554	
226	05	MATERIAL COST	1172-1178	9(07)	MTL-CST24-PL109V3	CDD0606795	
227	05	CONTRACTOR COST	1179-1185	9(07)	CONTR-CST22-PL109V3	CDD0606719	
228	05	OTHER COST	1186-1191	9(06)	OTHR-CST24-PL109V3	CDD0606980	
229	05	OFFICERS PAY DOLLARS	1192-1197	9(06)	OFF-PAY-DOL17-PL109V3	CDD0606715	
230	05	AIRMEN PAY DOLLARS	1198-1203	9(06)	AMN-PAY-DOL26-PL109V3	CDD0606716	
231	05	CIVILIANS PAY DOLLARS	1204-1209	9(06)	CIV-PAY-DOL25-PL109V3	CDD0606717	
232	03	DIRECTORATE OF DISTRIBUTION COST	1210-1247	X(038)	DIR-DISTR-CST-PL109V3	CDD0500559	
233	05	MATERIAL COST	1210-1216	9(07)	MTL-CST25-PL109V3	CDD0606795	
234	05	CONTRACTOR COST	1217-1223	9(07)	CONTR-CST23-PL109V3	CDD0606719	
235	05	OTHER COST	1224-1229	9(06)	OTHR-CST25-PL109V3	CDD0606980	
236	05	OFFICERS PAY DOLLARS	1230-1235	9(06)	OFF-PAY-DOL18-PL109V3	CDD0606715	
237	05	AIRMEN PAY DOLLARS	1236-1241	9(06)	AMN-PAY-DOL27-PL109V3	CDD0606716	
238	05	CIVILIANS PAY DOLLARS	1242-1247	9(06)	CIV-PAY-DOL26-PL109V3	CDD0606717	
239	03	DIRECTORATE OF MATERIEL MANAGEMENT COST	1248-1285	X(038)	DMM-CST-PL109V3	CDD0500560	
240	05	MATERIAL COST	1248-1254	9(07)	MTL-CST26-PL109V3	CDD0606795	
241	05	CONTRACTOR COST	1255-1261	9(07)	CONTR-CST24-PL109V3	CDD0606719	
242	05	OTHER COST	1262-1267	9(06)	OTHR-CST26-PL109V3	CDD0606980	
243	05	OFFICERS PAY DOLLARS	1268-1273	9(06)	OFF-PAY-DOL19-PL109V3	CDD0606715	
244	05	AIRMEN PAY DOLLARS	1274-1279	9(06)	AMN-PAY-DOL28-PL109V3	CDD0606716	
245	05	CIVILIANS PAY DOLLARS	1280-1285	9(06)	CIV-PAY-DOL27-PL109V3	CDD0606717	
246	03	DIRECTORATE OF PROCUREMENT COST	1286-1323	X(038)	DIR-PRCUR-CST-PL109V3	CDD0500561	
247	05	MATERIAL COST	1286-1292	9(07)	MTL-CST27-PL109V3	CDD0606795	
248	05	CONTRACTOR COST	1293-1299	9(07)	CONTR-CST25-PL109V3	CDD0606719	
249	05	OTHER COST	1300-1305	9(06)	OTHR-CST27-PL109V3	CDD0606980	
250	05	OFFICERS PAY DOLLARS	1306-1311	9(06)	OFF-PAY-DOL20-PL109V3	CDD0606715	
251	05	AIRMEN PAY DOLLARS	1312-1317	9(06)	AMN-PAY-DOL29-PL109V3	CDD0606716	
252	05	CIVILIANS PAY DOLLARS	1318-1323	9(06)	CIV-PAY-DOL28-PL109V3	CDD0606717	
253	03	SECOND DESTINATION TRANSPORTATION COST	1324-1330	9(07)	2ND-DEST-TRANS-CST-PL109V3	CDD0606727	
254	03	OFFICERS FLYING ADVANCED TRAINING COST	1331-1337	9(07)	OFF-FLY-AT-CST-PL109V3	CDD0606724	
255	03	AIRMEN FLYING ADVANCED TRAINING COST	1338-1344	9(07)	AMN-FLY-AT-CST-PL109V3	CDD0606725	
256	03	OFFICERS ADVANCED TRAINING COST	1345-1350	9(06)	OFF-AT-CST-PL109V3	CDD0606728	
257	03	AIRMEN ADVANCED TRAINING COST	1351-1356	9(06)	AMN-AT-CST-PL109V3	CDD0606729	
258	03	OFFICERS MEDICAL COST	1357-1362	9(06)	OFF-MED-CST-PL109V3	CDD0606730	
259	03	AIRMEN MEDICAL COST	1363-1368	9(06)	AMN-MED-CST-PL109V3	CDD0606731	
260	03	OFFICERS PERMANENT CHANGE OF STATION COST	1369-1374	9(06)	OFF-PCS-CST-PL109V3	CDD0606732	
261	03	AIRMEN PERMANENT CHANGE OF STATION COST	1375-1380	9(06)	AMN-PCS-CST-PL109V3	CDD0606733	
262	03	OFFICER PERSONNEL REPLACEMENT COST	1381-1386	9(06)	OFF-PERS-REPL-CST-PL109V3	CDD0606734	
263	03	AIRMEN PERSONNEL REPLACEMENT COST	1387-1392	9(06)	AMN-PERS-REPL-CST-PL109V3	CDD0606735	
264	03	LOCATION NAME	1393-1412	X(020)	LOC-NM-PL109V3	CDD0606690	

SS-K 11058D
D160C

ALIAS : PL109V3
MNEMONIC : D160C040005

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RECORD NAME : WSSC AF HISTORY
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MSTR ALIAS :

ELM NR	LVL NR	DATA ELEMENT,LONG TITLE (FIRST 45 CHARS)	LOC-RCD	PIC	COBOL DATA NAME	MNEMONIC	STID
285	03	FILLER	1413-1420	X(008)	FILLER		

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L	Elem #
001	01						
002	03	Year, Fiscal		Computer Year + 1		Computer Year +1	
003	03	Mission Design and Series		C-10	004	C-10	004
004	05	Mission, Classified					
005	05	Mission, Modified					
006	05	Mission					
007	05	Design					
008	05	Series					
009	03	Command		C-10	002	blanks	
010	03	Geographic Location		C-10	003	blanks	
011	03	Record Identifier		blanks		blanks	
012	03	Number of Possessed Aircraft		C-10	012	*Compute	
013	03	Number of Assigned Aircraft		N/A	Zeros	N/A	Zeros

*Number of possessed aircraft at MDS level = Possessed ACFT Hours, summed to MDS level divided by the number of hours in a year (8760).

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L Elem #
014	03	Hours, Possessed, Aircraft		C-10	010	sum by MDS
015	03	Hours, Flying		C-10	011	sum by MDS
016	03	Number of Crews		C-100	010	Zeros
017	03	Cost, Aircrew	020&021	C-39	010	C-39
018	05	Dollars, Pay, Officer			011	sum by MDS
019	05	Dollars, Pay, Airmen			012	sum by MDS
020	05	Number of Officers			013	sum by MDS
021	05	Number of Airmen			014	sum by MDS
022	03	Cost, Command Staff	025 thru 029	C-39	015	C-39
023	05	Cost, Material			016	sum by MDS
024	05	Cost, Other			017	sum by MDS
025	05	Dollars, Pay, Officer			018	sum by MDS
026	05	Dollars, Pay, Airmen			019	sum by MDS
027	05	Dollars, Pay, Civilians			020	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L Elem #	by MDS R/L Elem #
028	05	Number of Officers		021	sum by MDS
029	05	Number of Airmen		022	sum by MDS
030	05	Number of Civilians		023	sum by MDS
031	03	Cost, Personnel, Other	034 thru 038	C-39 024	C-39
032	05	Cost, Material		025	sum by MDS
033	05	Cost, Other		026	sum by MDS
034	05	Dollars, Pay, Officer		027	sum by MDS
035	05	Dollars, Pay, Airmen		028	sum by MDS
036	05	Dollars, Pay, Civilians		029	sum by MDS
037	05	Number of Officers		030	sum by MDS
038	05	Number of Airmen		031	sum by MDS
039	05	Number of Civilians		032	sum by MDS
040	03	Cost, Security	043,044&045	C-51	C-51
041	05	Dollars, Pay, Officer		011	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L	Elem #
042	05	Dollars, Pay, Airmen			013	sum by MDS	
043	05	Dollars, Pay, Civilians			015	sum by MDS	
044	05	Number of Officers			010	sum by MDS	
045	05	Number of Airmen			012	sum by MDS	
046	05	Number of Civilians			014	sum by MDS	
047	03	Cost, Petroleum Oil and Lubricants		C-70	010	C-68	008
048	03	Gallons of Fuel		C-70	011	C-68	009
049	03	Training Munitions Cost		C-73	010	C-74	008
050	03	Cost, Maintenance, Chief of	051 thru 056	C-44	010	C-44	
051	05	Cost, Material			014	sum by MDS	
052	05	Cost, Contractor			015	sum by MDS	
053	05	Cost, Other			016	sum by MDS	
054	05	Dollars, Pay, Officer			011	sum by MDS	
055	05	Dollars, Pay, Airmen			012	sum by MDS	

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L Elem #
056	05	Dollars, Pay, Civilians			013	sum by MDS
057	05	Number of Offices			017	sum by MDS
058	05	Number of Airmen			018	sum by MDS
059	05	Number of Civilians			019	sum by MDS
060	03	Cost, Maintenance, Avionics	061 thru 066	C-44	020	C-44
061	05	Cost, Material			024	sum by MDS
062	05	Cost, Contractor			025	sum by MDS
063	05	Cost, Other			026	sum by MDS
064	05	Dollars, Pay, Officer			021	sum by MDS
065	05	Dollars, Pay, Airmen			022	sum by MDS
066	05	Dollars, Pay, Civilians			023	sum by MDS
067	05	Number of Officers			027	sum by MDS
068	05	Number of Airmen			028	sum by MDS
069	05	Number of Civilians			029	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L Elem #
070	03	Cost, Maintenance, Field	071 thru 076	C-44	030	C-44
071	05	Cost, Material			034	sum by MDS
072	05	Cost, Contractor			035	sum by MDS
073	05	Cost, Other			036	sum by MDS
074	05	Dollars, Pay, Officer			031	sum by MDS
075	05	Dollars, Pay, Airmen			032	sum by MDS
076	05	Dollars, Pay, Civilians			033	sum by MDS
077	05	Number of Officers			037	sum by MDS
078	05	Number of Airmen			038	sum by MDS
079	05	Number of Civilians			039	sum by MDS
080	03	Cost, Maintenance, Missile, Munitions	081 thru 086	C-44	040	C-44
081	05	Cost, Material			044	sum by MDS
082	05	Cost, Contractor			045	sum by MDS
083	05	Cost, Other			046	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base		by MDS
					R/L Elem #	R/L Elem #
084	05	Dollars, Pay, Officer			041	sum by MDS
085	05	Dollars, Pay, Airmen			042	sum by MDS
086	05	Dollars, Pay, Civilians			043	sum by MDS
087	05	Number of Officers			047	sum by MDS
088	05	Number of Airmen			048	sum by MDS
089	05	Number of Civilians			049	sum by MDS
090	03	Cost, Maintenance, Organizational	091 thru 096	C-44	050	C-44
091	05	Cost, Material			054	sum by MDS
092	05	Cost, Contractor			055	sum by MDS
093	05	Cost, Other			050	sum by MDS
094	05	Dollars, Pay, Officer			051	sum by MDS
095	05	Dollars, Pay, Airmen			052	sum by MDS
096	05	Dollars, Pay, Civilians			053	sum by MDS
097	05	Number of Officers			057	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L Elem #		by MDS R/L Elem #
098	05	Number of Airmen			058	sum by MDS
099	05	Number of Civilians			059	sum by MDS
100	03	Cost, Squadron, Generation, Aircraft	101 thru 106	C-44	060	C-44
101	05	Cost, Material			064	sum by MDS
102	05	Cost, Contractor			065	sum by MDS
103	05	Cost, Other.			066	sum by MDS
104	05	Dollars, Pay, Officer			061	sum by MDS
105	05	Dollars, Pay, Airmen			062	sum by MDS
106	05	Dollars, Pay, Civilians			063	sum by MDS
107	05	Number of Officers			067	sum by MDS
108	05	Number of Airmen			068	sum by MDS
109	05	Number of Civilians			069	sum by MDS
110	03	Cost, Squadron, Repair, Component	111 thru 116	C-44	070	C-44
111	05	Cost, Material			074	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L Elem #
112	05	Cost, Contractor			075	sum by MDS
113	05	Cost, Other			076	sum by MDS
114	05	Dollars, Pay, Officer			071	sum by MDS
115	05	Dollars, Pay, Airmen			072	sum by MDS
116	05	Dollars, Pay, Civilians			073	sum by MDS
117	05	Number of Officers			077	sum by MDS
118	05	Number of Airmen			078	sum by MDS
119	05	Number of Civilian			079	sum by MDS
120	03	Cost, Squadron, Maintenance, Equipment	121 thru 126	C-44	080	C-44
121	05	Cost, Material			084	sum by MDS
122	05	Cost, Contractor			085	sum by MDS
123	05	Cost, Other			086	sum by MDS
124	05	Dollars, Pay, Officer			081	sum by MDS
125	05	Dollars, Pay, Airmen			082	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L Elem #
126	05	Dollars, Pay, Civilians			083	sum by MDS
127	05	Number of Officers			087	sum by MDS
128	05	Number of Airmen			088	sum by MDS
129	05	Number of Civilians			089	sum by MDS
130	03	Cost, Real Property Maintenance, Below Depot	131 thru 136	C-54	011	C-54
131	05	Cost, Material			015	sum by MDS
132	05	Cost, Contractor			016	sum by MDS
133	05	Cost, Other			017	sum by MDS
134	05	Dollars, Pay, Officer			012	sum by MDS
135	05	Dollars, Pay, Airmen			013	sum by MDS
136	05	Dollars, Pay, Civilians			014	sum by MDS
137	03	Cost, Communications, Below Depot	138 thru 143	C-54	018	C-54
138	05	Cost, Material			022	sum by MDS
139	05	Cost, Contractor			023	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L Elem #		by MDS R/L Elem #	
140	05	Cost, Other			024	sum by MDS	
141	05	Dollars, Pay, Officer			019	sum by MDS	
142	05	Dollars, Pay, Airmen			020	sum by MDS	
143	05	Dollars, Pay, Civilians			021	sum by MDS	
144	03	Cost, Base Operating Support, Below Depot	145 thru 150	C-54	025	C-54	
145	05	Cost, Material			029	sum by MDS	
146	05	Cost, Contractor			030	sum by MDS	
147	05	Cost, Other			031	sum by MDS	
148	05	Dollars, Pay, Officer			026	sum by MDS	
149	05	Dollars, Pay, Airmen			027	sum by MDS	
150	03	Dollars, Pay, Civilians			028	sum by MDS	
151	03	Cost, Spares, Replacement (Class 5)		C-76	011	C-77	009
152	03	Cost, Material, Modification Kits (Class 1)		C-76	011	C-77	009

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L	Elem #
153	03	Cost, Replacement Support Equip		N/A	zero		zero
154	03	Cost, Aircraft Overall	155 thru 159	C-64	010	C-62	008
155	05	Cost, Material			011		009
156	05	Cost, Contractor			012		010
157	05	Cost, Other			013		011
158	05	Dollars, Pay, Airmen			015		013
159	05	Dollars, Pay, Civilians			016		014
160	03	Cost, Engine Overall	161 thru 165	C-64	017	C-62	015
161	05	Cost, Material			018		016
162	05	Cost, Contractor			019		017
163	05	Cost, Other			020		018
164	05	Dollars, Pay, Airmen			022		020
165	05	Dollars, Pay, Civilians			023		021
166	03	Cost, Engine, Accessories	167 thru 171	C-64	024	C-62	022

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base		by MDS	
					R/L Elem #		R/L Elem #
167	05	Cost, Material			025		023
168	05	Cost, Contractor			026		024
169	05	Cost, Other			027		025
170	05	Dollars, Pay, Airmen			029		027
171	05	Dollars, Pay, Civilians			030		028
172	03	Cost, Aircraft Accessories	173 thru 177	C-64	031	C-62	029
173	03	Cost, Material			032		030
174	05	Cost, Contractor			033		031
175	05	Cost, Other			034		032
176	05	Dollars, Pay, Airmen			036		034
177	05	Dollars, Pay, Civilian			037		035
178	03	Cost, Avionics Instrumentation	179 thru 183	C-64	038	C-62	036
179	05	Cost, Material			039		037
180	05	Cost, Contractor			040		038

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L	Elem #
181	05	Cost, Other			041		039
182	05	Dollars, Pay, Airmen			043		041
183	05	Dollars, Pay, Civilians			044		042
184	03	Cost, Avionics Communication	185 thru189	C-64	045	C-62	043
185	05	Cost, Material			046		044
186	05	Cost, Contractor			047		045
187	05	Cost, Other			048		046
188	05	Dollars, Pay, Airmen			050		048
189	05	Dollars, Pay, Civilians			051		049
190	03	Cost, Avionics Navigation	191 thru 195		052		050
191	05	Cost, Material			053		051
192	05	Cost, Contractor			054		052
193	05	Cost, Other			055		053
194	05	Dollars, Pay, Airmen			057		055
195	05	Dollars, Pay, Civilian			058		056

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	by MDS/Cmd/Base Elem #	by MDS R/L	by MDS Elem #
196	03	Cost, Armament	197 thru 201	C-64	059	C-62	057
197	05	Cost, Material			060		058
198	05	Cost, Contractor			061		059
199	05	Cost, Other			062		060
200	05	Dollars, Pay, Airmen			064		062
201	05	Dollars, Pay, Civilians			065		063
202	03	Cost, Support Equipment	203 thru 207	C-64	066	C-62	064
203	05	Cost, Material			067		065
204	05	Cost, Contractor			068		066
205	05	Cost, Other			069		067
206	05	Dollars, Pay, Airmen			071		069
207	05	Dollars, Pay, Civilians			072		070
208	03	Cost, Class IV Modification Installation		C-64	073	C-62	071
209	03	Cost, Interim Contractor Support			074		072

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L Elem #		by MDS R/L Elem #
210	03	Cost, Contract Logistics Support			075	073
211	03	Cost, Depot Level maint, Real Property	212 thru 217	C-56	012	C-56
212	05	Cost, Material			016	sum by MDS
213	05	Cost, Contractor			017	sum by MDS
214	05	Cost, Other			018	sum by MDS
215	05	Dollars, Pay, Officer			013	sum by MDS
216	05	Dollars, Pay, Airmen			014	sum by MDS
217	05	Dollars, Pay, Civilians			015	sum by MDS
218	03	Cost, Depot Level Main, Communications	219 thru 224	C-56	019	C-56
219	05	Cost, Material			023	sum by MDS
220	05	Cost, Contractor			024	sum by MDS
221	05	Cost, Other			025	sum by MDS
222	05	Dollars, Pay, Officer			020	sum by MDS
223	05	Dollars, Pay, Airmen			021	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base		by MDS
				R/L Elem #		R/L Elem #
224	05	Dollars, Pay, Civilians			022	sum by MDS
225	03	Cost, Base Operations, Depot	226 thru 231	C-56	026	C-56
226	05	Cost, Material			030	sum by MDS
227	05	Cost, Contractor			031	sum by MDS
228	05	Cost, Other			032	sum by MDS
229	05	Dollars, Pay, Officer			027	sum by MDS
230	05	Dollars, Pay, Airmen			028	sum by MDS
231	05	Dollars, pay, Civilians			029	sum by MDS
232	03	Cost, Distribution, Directorate of	233 thru 238	C-56	033	C-56
233	05	Cost, Material			037	sum by MdS
234	05	Cost, Contractor			038	sum by MDS
235	05	Cost, Other			039	sum by MDS
236	05	Dollars, Pay, Officer			034	sum by MDS
237	05	Dollars, Pay, Airmen			035	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L Elem #		by MDS R/L Elem #
238	05	Dollars, Pay, Civilians			036	sum by MDS
239	03	Cost, Director of Materiel Management	240 thru 245	C-56	040	C-56
240	05	Cost, Material			040	sum by MDS
241	05	Cost, Contractor			045	sum by MDS
242	05	Cost, Other			046	sum by MDS
243	05	Dollars, pay, Officer			041	sum by MDS
244	05	Dollars, Pay, Airmen			042	sum by MDS
245	05	Dollars, Pay, Civilians			043	sum by MDS
246	03	Cost, Procurement, Directorate of	247 thru 252	C-56	047	C-56
247	05	Cost, Material			051	sum by MDS
248	05	Cost, Contractor			052	sum by MDS
249	05	Cost, Other			053	sum by MDS
250	05	Dollars, Pay, Officer			048	sum by MDS
251	05	Dollars, Pay, Airmen			049	sum by MDS

Elem Nr	Lvl Nr	WSSC AF-History	Report Total	by MDS/Cmd/Base R/L	Elem #	by MDS R/L	Elem #
252	05	Dollars, Pay, Civilians			050	sum by MDS	
253	03	Cost, Second Destination Transportation		N/A	zeros	N/A	zeros
254	03	Cost, Advanced Training, Flying, Officers		N/A	zeros	N/A	zeros
255	03	Cost, Advanced Training, Flying, Airmen		N/A	zeros	N/A	zeros
256	03	Cost, Advanced Training, Officers		N/A	zeros	N/A	zeros
257	03	Cost, Advanced Training, Airmen		N/A	zeros	N/A	zeros
258	03	Cost, medical Officers		C-50	012	C-50	sum
259	03	Cost, medical, Airmen		C-50	013	C-50	sum
260	03	Cost, Permanent Change of Station, Officer		C-50	010	C-50	sum
261	03	Cost, Permanent Change of Station, Airmen		C-50	011	C-50	sum
262	03	Cost, Personnel Replacement, Officer		N/A	zeros	N/A	zeros
263	03	Cost, Personnel Replacement, Airmen		N/A	zeros	N/A	zeros
264	03	Name, location (of GELOC)		C-10	013	N/A	

MDS T037B
POSSESSED NUMBER OF AIRCRAFT 629 82 FLYING HOURS 312749

(COSTS EXPRESSED IN MILLIONS OF DOLLARS)

OPERATING AND SUPPORT COST - MDS TOTAL 351.518

	OFFICER	AIRMAN	CIVILIAN	TOTAL
UNIT MISSION PERSONNEL				
AIRCREW	42 098	.000		42 098
MAINTENANCE PERSONNEL	2 468	42.624	9 000	54.092
ORGANIZATIONAL/INTERMEDIATE	1 046	37.517	6 967	45 530
ORDNANCE	000	.000	000	000
OTHER MAINT PERSONNEL	1 422	5 107	2 033	8 562
OTHER UNIT PERSONNEL	24 215	22 102	1.077	47 394
UNIT STAFF	24 215	22.102	1 077	47.384
SECURITY	000	.000	000	000
REMAINING UNIT PERSONNEL	000	.000	000	000
UNIT LEVEL CONSUMPTION				62 097
AVFUEL **(57.389.070 GALLONS)**				45.231
MAINTENANCE MATERIEL				16 866
TRAINING ORDNANCE (MUNITIONS)				000

	DEPOT LABOR	MATERIEL	CONTRACT SERVICES	GFM	
DEPOT LEVEL MAINTENANCE	3 509	1 613	9 312	3 261	17 695
AIRCRAFT OVERHAUL	000	.000	1 458	000	1.458
ENGINE OVERHAUL	000	000	683	1 538	2 221
ENGINE ACCESSORIES	122	054	3 628	1 017	4 821
AIRCRAFT ACCESSORIES	2 601	1 413	2 413	696	7 123
AVIONICS INSTRUMENTATION	.018	007	026	000	051
AVIONICS COMMUNICATIONS	211	041	469	000	721
AVIONICS NAVIGATION	.299	082	537	010	928
ARMAMENT	000	000	000	000	000
SUPPORT EQUIPMENT	258	016	098	000	372
CLASS IV MODIFICATION INSTALLATION					001
INTERIM CONTRACTOR SUPPORT					.000
CONTRACTOR LOGISTICS SUPPORT					000

ACCV(VAMOSC) (1) AIRCRAFT OPERATING AND SUPPORT COSTS 10 APR 87 Q 0160C WOO WS MWS
RCS HAF LEY(A&AR)8203(DD)
CAIG FORMAT FY 86

MDS T037B
(CONTINUED)

(COSTS EXPRESSED IN MILLIONS OF DOLLARS)

	OFFICER	AIRMAN	CIVILIAN	TOTAL
SUSTAINING INVESTMENTS				4.916
REPARABLE SPARES				4.882
REPLACEMENT SUPPORT EQUIPMENT				****
MODIFICATION KITS				.034
INSTALLATION SUPPORT PERSONNEL	3.241	16.038	13.639	32.918
REAL PROPERTY MAINTENANCE	.507	4.277	5.215	9.999
COMMUNICATIONS	.107	.300	.615	1.022
BASE OPERATING SUPPORT	2.627	11.461	7.809	21.897
INDIRECT PERSONNEL SUPPORT				47.774
MEDICAL				3.458
MISC OPERATIONS AND MAINT				40.940
PERMANENT CHANGE OF STATION				3.376
DEPOT NON-MAINTENANCE				42.533
GENERAL DEPOT-SUPPORT				42.533
SECOND DESTINATION TRANS				****
PERSONNEL ACQUISITION AND TNG	****	****		.000

ACCV(VAMOSC) (1)   A[illegible]RAFT OPERATING AND SUPPORT COST   10 APR 87   (D160C-WOD-WS-MWS
RCS: HAF LEY(A&AR)9203(DD)
CAIG FORMAT   FY 86

MDS T038A
POSSESSED NUMBER OF AIRCRAFT 657.17   FLYING HOURS 312775

(COSTS EXPRESSED IN MILLIONS OF DOLLARS)

OPERATING AND SUPPORT COST - MDS TOTAL   522.171

	OFFICER	AIRMAN	CIVILIAN	TOTAL
UNIT MISSION PERSONNEL				
AIRCREW	41.005	.000		41.005
MAINTENANCE PERSONNEL	4.114	80.067	14.630	98.811
ORGANIZATIONAL/INTERMEDIATE	1.783	71.304	12.503	85.590
ORDNANCE	.000	.009	.000	.009
OTHER MAINT PERSONNEL	2.331	8.754	2.127	13.212
OTHER UNIT PERSONNEL	17.410	22.029	.869	40.308
UNIT STAFF	17.410	22.009	.869	40.288
SECURITY	.000	.000	.000	.000
REMAINING UNIT PERSONNEL	.000	.020	.000	.020
UNIT LEVEL CONSUMPTION				133.744
AVFUEL **(125,130,034 GALLONS)**				98.543
MAINTENANCE MATERIEL				35.201
TRAINING ORDNANCE (MUNITIONS)				.000

	DEPOT LABOR	MATERIEL	CONTRACT SERVICES	GFM	TOTAL
DEPOT LEVEL MAINTENANCE	8.551	4.506	11.634	9.516	34.207
AIRCRAFT OVERHAUL	.638	.276	.217	.000	1.131
ENGINE OVERHAUL	.023	.000	.611	1.083	1.717
ENGINE ACCESSORIES	.063	.024	7.637	6.392	14.116
AIRCRAFT ACCESSORIES	6.275	2.978	2.610	1.962	13.825
AVIONICS INSTRUMENTATION	.035	.015	.011	.000	.061
AVIONICS COMMUNICATIONS	.655	.254	.123	.000	1.032
AVIONICS NAVIGATION	.160	.043	.424	.079	.706
ARMAMENT	.000	.000	.000	.000	.000
SUPPORT EQUIPMENT	.702	.916	.001	.000	1.619
CLASS IV MODIFICATION INSTALLATION					9.840
INTERIM CONTRACTOR SUPPORT					.000
CONTRACTOR LOGISTICS SUPPORT					.000

MDS TO38A
(CONTINUED)

(COSTS EXPRESSED IN MILLIONS OF DOLLARS)

	OFFICER	AIRMAN	CIVILIAN	TOTAL
SUSTAINING INVESTMENTS				16 844
REPARABLE SPARES				16 713
REPLACEMENT SUPPORT EQUIPMENT				****
MODIFICATION KITS				.131
INSTALLATION SUPPORT PERSONNEL	4 370	22 266	16 697	43 333
REAL PROPERTY MAINTENANCE	687	5 804	6 459	12 950
COMMUNICATIONS	109	305	687	1 101
BASE OPERATING SUPPORT	3 574	16 157	9 551	29 282
INDIRECT PERSONNEL SUPPORT				59 712
MEDICAL				4 789
MISC OPERATIONS AND MAINT				49 925
PERMANENT CHANGE OF STATION				4 998
DEPOT NON-MAINTENANCE				44 367
GENERAL DEPOT-SUPPORT				44 367
SECOND DESTINATION TRANS				****
PERSONNEL ACQUISITION AND TNG	****	****		000

ACCVIVAMUSCI (1) [illegible] AIRCRAFT OPERATING [illegible] COST [illegible] [illegible] AIR B [illegible]

[illegible] 303

[illegible] 86

MDS T037B
FLYING HOURS 312749

POSSESSED NUMBER OF AIRCRAFT 629 82

DOLLAR COST IN MILLIONS

DESCRIPTION	TOTAL	MATERIEL	CONTRACT	OTHER	PAY & ALLOWANCES OFFICER	AIRMEN	CIVILIAN	WORK LOAD DISTRIBUTION OFF	AMN	CIV
TOTAL EXPENDITURES	[illegible] 510	8 4[illegible]	[illegible]	16 1[illegible]7	4 [illegible]	61 963	58 [illegible]72	1324	2553	679
UNIT OPERATIONS	142 588	48 [illegible]8		5 016	66 313	22 102	1 077	1274	789	377
AIRCREW	42 [illegible]18				42 [illegible]98	(000)		852	0	
COMMAND STAFF	55 259	2 849		5 016	24 215	22 102	1 077	422	789	377
OTHER UNIT PERSONNEL	(000)	[illegible]		(000)	(000)	(000)	(000)	0	0	0
SECURITY	(000)				[illegible]	(000)	(000)	0	0	0
AVFUEL	45 2[illegible]	45 2[illegible]	*** 57 389 070 GA[illegible]							
MUNITIONS TRAINING	(000)	[illegible]								
BELOW DEPOT MAINTENANCE	79 782	16 8[illegible]	7 551	673	[illegible]	42 624	[illegible]	50	1764	102
CHIEF OF MAINT	[illegible]	[illegible]	1 [illegible]99	284	1 4[illegible]	5 [illegible]	2 [illegible]	25	174	49
AVIONICS MAINT	5 930	1 [illegible]	1 074	[illegible]	[illegible]	2 649	1 [illegible]42	2	[illegible]	30
FIELD MAINT	[illegible] 151	11 [illegible]	1 24[illegible]	[illegible]	[illegible]8	[illegible]	4 [illegible]	8	502	175
MUNITIONS/MISSLE MAINT	(000)	[illegible]	(000)	(000)	[illegible]	(000)	(000)	0	0	0
ORGANIZATIONAL MAINT	[illegible] 184	3 [illegible]	3 937	151	[illegible]	20 802	1 041	15	904	48
AIRCRAFT GENERATION SQ	724	[illegible]	(000)	[illegible]	[illegible]	632	[illegible]	0	25	0
COMPONENT REPAIR SQ	1 185	215	[illegible]	[illegible]	[illegible]	912	[illegible]12	0	37	0
EQUIPMENT MAINT SQ	543	[illegible]	(000)	[illegible]	[illegible]	443	[illegible]	0	19	0
INSTALLATION SUPPORT	42 490	3 [illegible]	[illegible] 330	2 777	2 494	13 810	8 477			
REAL PROPERTY MAINT	1[illegible] 152	1 829	6 144	1 858	416	3 522	3 393			
COMMUNICATIONS	1 1[illegible]	[illegible]	141	536	(000)	[illegible]4	297			
BASE OPERATIONS	24 1[illegible]	1 598	5 045	383	[illegible]	10 284	4 787			
SUSTAINING INVESTMENT	4 916	4 916								
REPLACEMENT SPARES	4 882	4 882								
MOD KITS/MATERIEL	034	[illegible]34								
REPLACEMENT SUPP EQUIP	****	****								

ACCV(VAMOSC) (1) AIRCRAFT OPERATING AND SUPPORT COSTS 10 APR 87 Q D160C WOF WS MWS

USAF DETAIL

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FY 86

MDS T037B

(CONTINUED)

DOLLAR COST IN MILLIONS

DESCRIPTION	TOTAL	MATERIEL	CONTRACT	OTHER	PAY & ALLOWANCES OFFICER	AIRMEN	CIVILIAN
DEPOT MAINTENANCE	17 695	1 613	12 571	1 569		005	1 936
AIRCRAFT OVERHAUL	1 458	000	1 458	000		000	000
ENGINE OVERHAUL	2 221	000	2 221	.000		000	000
ENGINE ACCESSORIES	4 821	.054	4 645	.055		000	067
AIRCRAFT ACCESSORIES	7 122	1 413	3.108	1 167		005	1 429
AVIONICS INSTRUMENTATION	051	007	026	007		000	011
AVIONICS COMMUNICATION	721	041	469	091		000	120
AVIONICS NAVIGATION	927	082	546	125		000	174
ARMAMENT	000	.000	.000	.000		000	000
SUPPORT EQUIPMENT	372	016	098	.123		000	135
CLASS IV MOD INSTALLATION	001			001			
INTERIM CONTRACTOR SUPPORT	000		000				
CONTRACT LOGISTICS SUPPORT	000		000				
DEPOT INSTALLATION SUPPORT	14 679	1 153	4 128	1 261	747	2 228	5 162
REAL PROPERTY MAINT	7 224	.530	3 523	.503	091	755	1 822
COMMUNICATIONS	1 279	.103	.026	429	.107	296	.318
BASE OPERATIONS	6 176	520	579	329	549	1 177	3 022
GENERAL DEPOT SUPPORT	42 533	2 233	3 582	1 153	1 587	858	33 120
SECOND DESTN TRNSP	....			....			
ADVANCE FLYING TRAINING	000			000			
OFFICER	....			....			
AIRMEN	....			....			
ADVANCE TRAINING	000			.000			
OFFICER	....			....			
AIRMEN	....			....			
MEDICAL CARE	3 458			3 458			
PCS	3 376				1 040	2 336	
PERSONNEL REPLACEMENT	000			000			
OFFICER	....			....			
AIRMEN	....			....			

[illegible] AIRCRAFT OPERATING AND SUPPORT CO 10 APR 87 [illegible] MDS WS MWS

USAF DET

MDS MAP [illegible]

FY 86

MDS TO38A

FLYING HOURS 312775

POSSESSED NUMBER OF AIRCRAFT 657 17

DOLLAR COST IN MILLIONS

DESCRIPTION	TOTAL	MATERIEL	CONTRACT	OTHER	PAY & ALLOWANCES OFFICER	AIRMEN	CIVILIAN	WORK LOAD DISTRIBUTION OFF	AMN	CIV
TOTAL EXPENDITURES	522 173	166 179	52 950	32 647	69 798	129 193	71 406	1203	4121	890
UNIT OPERATIONS	189 018	101 340		6 365	58 415	22 029	869	1120	785	342
AIRCREW	41 005				41 005	000		822	0	
COMMAND STAFF	49 441	2 788		6 365	17 410	22 008	869	298	784	342
OTHER UNIT PERSONNEL	029	009		000	000	020	000	0	1	0
SECURITY	000				000	000	000	0	0	0
AVFUEL	98 543	98 543	**(125,130,034 GALLONS)**							
MUNITIONS TRAINING	000	000								
BELOW DEPOT MAINTENANCE	144 531	35 201	8 851	1 668	4 114	80 067	14 630	83	3336	548
CHIEF OF MAINT	16 255	806	1 806	431	2 331	8 754	2 127	41	298	79
AVIONICS MAINT	9 074	1 689	1 228	041	087	4 432	1 597	1	176	48
FIELD MAINT	65 872	25 977	2 351	.903	642	26 800	9 199	15	1123	343
MUNITIONS/MISSLE MAINT	009	000	000	.000	000	.009	000	0	0	1
ORGANIZATIONAL MAINT	50 232	6.184	3 463	.247	989	37.747	1 602	25	1643	73
AIRCRAFT GENERATION SQ	1 526	218	.002	011	.039	1 252	.004	1	52	0
COMPONENT REPAIR SQ	428	130	001	010	008	243	036	0	10	1
EQUIPMENT MAINT SQ	1 135	197	000	025	018	830	065	0	34	3
INSTALLATION SUPPORT	58 632	4 783	15 009	3.790	3 610	19 998	11 442			
REAL PROPERTY MAINT	24 025	2 479	8 824	2.488	595	5 035	4 604			
COMMUNICATIONS	1 513	234	.147	765	000	004	363			
BASE OPERATIONS	33 094	2 070	6 038	537	3 015	14 959	6 475			
SUSTAINING INVESTMENT	16 844	16 844								
REPLACEMENT SPARES	16.713	16.713								
MOD KITS/MATERIEL	.131	.131								
REPLACEMENT SUPP EQUIP	****	****								

USAF DETAIL
RCS HAF LEV(A)8103
FY 86

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(CONTINUED)

DOLLAR COST IN MILLIONS

DESCRIPTION	TOTAL	MATERIEL	CONTRACT	OTHER	PAY & ALLOWANCES OFFICER	AIRMEN	CIVILIAN
DEPOT MAINTENANCE	51 889	4 506	21 151	13 550		181	4 661
AIRCRAFT OVERHAUL	1 131	276	217	273		176	189
ENGINE OVERHAUL	1 717	000	1 694	012		000	011
ENGINE ACCESSORIES	14 118	024	14 030	.031		.000	033
AIRCRAFT ACCESSORIES	13 825	2 978	4 572	2 675		005	3 595
AVIONICS INSTRUMENTATION	061	015	011	015		000	020
AVIONICS COMMUNICATION	1 032	254	123	290		000	365
AVIONICS NAVIGATION	706	043	503	066		000	074
ARMAMENT	000	000	000	000		000	000
SUPPORT EQUIPMENT	1 619	916	001	.348		.000	354
CLASS IV MOD INSTALLATION	9 840			9 840			
INTERIM CONTRACTOR SUPPORT	000		000				
CONTRACT LOGISTICS SUPPORT	000		000				
DEPOT INSTALLATION SUPPORT	14 945	1 175	4 203	1 284	760	2 268	5 255
REAL PROPERTY MAINT	7 354	540	3 586	512	092	.769	1 855
COMMUNICATIONS	1 303	105	027	437	109	301	324
BASE OPERATIONS	6 288	530	590	335	559	1 198	3 076
GENERAL DEPOT SUPPORT	44 367	2 330	3 736	1 201	1 656	895	34 549
SECOND DESTN TRNSP	****			****			
ADVANCE FLYING TRAINING	000			.000			
OFFICER	****			****			
AIRMEN	****			****			
ADVANCE TRAINING	000			.000			
OFFICER	****			****			
AIRMEN	****			****			
MEDICAL CARE	4 789			4 789			
PCS	4 998				1 243	3 755	
PERSONNEL REPLACEMENT	000			000			
OFFICER	****			****			
AIRMEN	****			****			

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VITA

Captain David F. Cortez was born on 18 December 1949 in San Antonio, Texas. He graduated from Thomas Jefferson High School and attended San Antonio College for two years prior to enlisting in the U.S. Air Force. He served in several comptroller assignments at Bergstrom AFB, Texas; George AFB, California; Ching Chuan Kang AB, Taiwan; and Lackland AFB, Texas. He received a Bachelor of Arts in Social Science from Chapman College in 1977. Upon receiving his commission from the Officers Training School in June 1978, he was assigned as the budget officer at Pope AFB, North Carolina until 1980. He then served at Hq Military Airlift Command, Scott AFB, Illinois as a budget analyst and comptroller inspector from January 1981 to May 1983. Captain Cortez was then assigned as an instructor and executive officer at the DoD Professional Military Comptroller School at Maxwell AFB, Alabama until May 1986. He then entered the School of Systems and Logistics, Air Force Institute of Technology. He was awarded a Master of Science Degree in Systems Management in September 1987. Captain Cortez was then assigned to the Cost Analysis Division, Comptroller Directorate, Hq Air Training Command, at Randolph AFB, Texas.

Permanent Address: 843 Barclay Avenue
San Antonio TX 78207

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Associate Professor of Quantitative Methods

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Block 19

Abstract

Fiscal legislation dictates the prudent, yet effective and efficient use of government funds for Department of the Air Force programs. Much attention has focused on the increased cost of weapon systems and on providing an accurate track of total weapon systems costs. Sophisticated data collection systems such as the Visibility and Management of Operating Support Cost (VAMOSC) system have been created to help track these costs.

Currently, supply and accounting computer systems do not fully capture the costs of aircraft supply issues by mission, design, and series (MDS) aircraft. Therefore, a cost allocation procedure is used to charge the costs of common items (bench stock) to specific aircraft by using a ratio involving maintenance man-hours.

This research investigates the relationship between unallocated base maintenance supplies (BMS) cost and several potential cost drivers using regression analysis. The study identifies the key relationship that drives cost and incorporates this knowledge into the allocation algorithm. Data for this study come from a stratified sample of flying training aircraft in Air Training Command. Eight bases are used reporting data for primary aircraft authorized (PAA), sorties, maintenance man-hours, flying hours, and direct BMS costs for FY 84-86.

In answering the research questions, relevant literature, expert opinion, and a priori judgment were used to select potential cost drivers. Then a regression model was derived and statistically tested for linearity, strength of association, and aptness.

The derived model indicated the best relationship between the given variables and unallocated BMS cost occurred when PAA is used. Empirical evidence is given to refute the use of maintenance man-hours in an allocation algorithm.

In the conclusion, a sample allocation calculation using PAA and maintenance man-hours is provided for comparison. Also, recommendations are made for future study and a comprehensive three month review of BMS issues is suggested.

END
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